The Development and Restructuring of China's Metal Mining Industry

Xu Tao

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Foreword

China has the potential to be both a major consumer of imported mineral products and a major competitor in world mineral markets. Many studies have been conducted on the extent of these potentials by western authors, using less-than-adequate published statistical data on Chinese resources, reserves, production, consumption, exports and imports. Much remains to be learned on this topic.

This study contributes to this ongoing research effort by providing an insider's view of some of the many parameters involved, including the organization of the mining industry in China; its place in the overall economy of China; its strengths and weaknesses; and its needs for change, for example in mining law, in management, and in investment policy.

The insights provided by the author have value on two levels. First, in the factual realm, much is offered that is not available in print in English. Statistical data are unfortunately still very scarce, but the descriptive material is useful and often fascinating. In the realm of perceptions, much can be learned from the author's approach to and understanding of topics such as planning, economic reform, and free markets. For any who wish to understand and work with their Chinese counterparts, such insights can be just as valuable as hard facts.

The Centre for Resource Studies is pleased to present this study as part of its ongoing support of research and communication in mineral policy and economics. Comments and feedback are welcomed.

The views expressed are those of the author and do not necessarily represent those of the Centre for Resource Studies or its sponsors.

Margot Wojciechowski
Centre for Resource Studies

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An immeasurable contribution in making this report much more acceptable to the Canadian audience has been made by Dr. Lo Sun Jen, whose efforts were indispensable to this project.

This project is designed to improve the linkage of mining economic studies, both inside and outside China. Suggestions and comments from the referees of early drafts of the report have also made a vital contribution. The author appreciates the efforts of all the scholars who have contributed to this study and assisted with publication of the final report.

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The People's Republic of China – Provinces

Source: A. Werner, *The Mineral Industry of China: Statistics and Locations*, Energy, Mines and Resources Canada, 1988.

1. Introduction

Object and Scope of the Study

Canada has a well-established mining industry. It could benefit from a growing demand in China for its mineral products and mining and processing technology, especially given the slow growth of demand among Canada's traditional major trading partners within the OECD. Increases in demand for mineral products in China, once its economy picks up, have the potential to make China a significant market for Canadian primary materials.

Interest in China's metal mining sector has grown since the late 1970s due to the common belief that a China in the process of economic reform would be an important potential consumer as well as a supplier of mineral products in the world market. Many articles have been published on this subject, and other research projects are in progress. The present study will focus on discussing the process of the reform and analyzing the potential for success of the anticipated restructuring of China's metal mining industry, a topic which is seldom considered in English language publications.

China's impact on world markets has the potential to be quite significant. Furthermore, many features of China's metal mining industry are unique, and it is impossible for the West to understand this simply from observing the mining industries of other countries. Promoting mutual understanding of these features across the Pacific will be a useful contribution to international trade. Colleagues in both China and Canada have collaborated to help fill this void in this study of the Chinese mining sector and to complement the projects of other researchers, which have tended to focus mainly on quantitative predictions of China's metal mineral market, both supply and demand.

Until the late 1980s, China's internal market was a source of growing interest to many mineral-exporting countries. For the generation of Chinese reaching middle age, this time provided a burst of unexpected social, political and economical initiatives that they could scarcely have imagined earlier.

More recently, China's economic growth has begun to slow down, and its consumption of metals has decreased. Consequently, the interest of international metal and mineral producers and traders in China has diminished as well. There are two aspects of China's metal consumption with implications for Westerners: diminishing ability to import mineral products since 1986, and the more recent decline of general social consumption.

There is a diversity of opinion among knowledgeable sources, both inside and outside China, concerning the potential for its metal mining industry and its metal consumption. While the current period has proven to be a disappointment for Western traders, it presents an opportunity for researchers to better understand China, realistically and in the long term. Hopefully some underlying problems can be identified and understood, particularly in this period of fluctuation when so many factors, temporary as well as fundamental, favourable and unfavourable, are in play.

In the course of this research, the author perceived that there are disputable issues of concern. For example, can and should China's mining sector be developed significantly? How would this development affect China's own economy? How would it affect international trade in minerals? Would it change recent patterns of world trade or general circumstance? These questions may be considered from different viewpoints and in different degrees of depth.

A commonly held opinion among China's economists in the early 1980s was that it would be irrational to develop a capital-intensive domestic mining industry, especially in view of the fact that China was not well-endowed in terms of mineral resources such as iron and copper. A series of reports concerning economic development strategy argued that focusing on manufacturing and high-technology was the correct way for the nation to develop its economy in the new era. In line with this advice, "exporting oil to support importing metals" was the dominant routine at that time. The importance of most primary sectors was significantly

downgraded in China's sixth five-year plan (1981-85) for social and economic development. As a result, China became the second-largest metal-importing country next to the United States and an active partner in many mineral and metal ventures all over the world at that time.

The simple manufacturing and high-technology development route had its drawbacks. Even before 1985, when world prices for oil were high and China's imports of metals were comparatively low, investment in the petro-development projects, to increase oil output and exports to support metal imports, was considerably higher than direct investment in the metal mining sector. Although mineral grades are generally low in China, domestic operations often have an inherent advantage, at least in domestic markets, because many are very labour-intensive and wage rates are low. However, the path chosen did not allow sufficient capital to develop these mineral resources.

The unexpected drop in oil prices and the increase in metal imports after 1985 caused a notable national trade deficit for China,[1] making the existing course of action impossible to continue, and challenged the sophisticated development strategy theories. Empirical evidence demonstrated, contrary to the arguments of the prevalent theory, that a minimum level of development of metal mining capacity was necessary for economic growth, and its absence had reduced China's ability to import other minerals and mineral products.

Some readers may be interested in reviewing the literature regarding China's various economic theories of the last decade, and comparing the theories with historical reality. However, it was considered more useful in the limited space of this report to focus on the much more up-to-date and practical issue of the potential for developing and restructuring the primary mineral sector in China, rather than merely analyzing out-dated arguments.

As a vast and rapidly developing country, it can be argued that China must develop its mineral potential, even though this potential and the capital resources for development are limited. The main reasons are that

- China has limited capacity for foreign exchange payments for imports of minerals and metals, and depends largely on oil for generating foreign exchange;

- its vast labour force needs the employment opportunities offered by primary resource development activities;

- if construction materials are in seriously short supply, due to both the lack of domestic production and the inability to import, one possible result will be the destruction, both legal and illegal, of already-scarce forest resources that will jeopardize not only China's environment, but global ecology on a large scale;

- heavy dependence on imports of minerals and mineral products requires exports of oil in order to generate foreign currency. This may increase the use of coal as fuel in China, and contribute to an acceleration of the global greenhouse effect.

Speaking from a long-term point of view, development of China's mining industry would be a positive step, not only for China but for the rest of the world as well, if it led to overall stable economic development for such a populous nation as China, along with a better global environment.

There is some concern among other mineral-producing countries that China's developing mining sector might become a competitor in world markets. Any steps taken to develop China's mineral industry will be motivated primarily by domestic needs. Competitors would be well advised to observe China's options as discussed in this report and other commentaries, and then to act according to the information available. This kind of competition, based on informed understanding, will ultimately benefit all contenders.

Even if China does turn to developing its mining capability, its capital resources and intentions are modest. It is unlikely that China will be able to meet its growing demand with domestic production for some time to come. The shortfall in supply will continue to be met by imports for at least two decades.

Despite the motions of the last decade towards a freer-enterprise system, China's economy is still primarily centrally planned. The mining industry is strongly tied into, and affected by, this general

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[1] Xu Tao: China's mining sector, fundamental reform needed (in English language), *CRS Perspectives*, No. 31, Centre for Resource Studies, Kingston, 1989.

system. As a result, a double-barrelled approach of reform and continuing operation and development will be required: a simultaneous operation and development of the component sectors, along with the broader background of overall economic restructuring and reform. Although the restructuring of mining, or any other industry, must occur in conjunction with overall restructuring, this report cannot offer a comprehensive solution to China's overall economic problems. After a brief commentary on China's general economic circumstances, the focus will narrow to the mining sector.

The author holds an optimistic point of view concerning the future of China's economy and its mining industry, as well as metal markets from the mid-1990s on. It is felt that the consequences of reform and the open-door policy of the 1980s, despite some obstacles, will be long-lasting and that the unsettled social conditions of the late 1980s are but a prelude to further progress. Undeniably, other options and alternatives may occur over time. Nevertheless, the suggestions and outlook for long-term restructuring of China's metal mining industry described here assume an auspicious social environment over the long term. At the same time, current difficulties and practical problems will not be neglected.

Although faith in the power of the market prevails widely among economists, both inside and outside of China, some evidence and an understanding of Chinese realities suggest that practical reform cannot move immediately from a centrally managed to a market economy. Although some would argue that a prolonged transition period would of itself lead to chaos, the author believes that in order to deal with Chinese realities and to avoid chaos, public-planning factors should be reduced gradually. Then, following this period of transition, both market and public-planning factors will be integrated in an evolutionary process. Therefore, when some continuing mandatory measures for public intervention are suggested in this report, it does not mean that an overall central-planning system is urged, but rather that a gradual approach to the market economy is recommended, rather than the rapid transition to market mechanisms that might be advised by others. When the industrial structure is so influenced by the planning process and structures, as it is in China, specially tailored initiatives are necessary in order to aid the transition to other forms of economic practice.

The deficiency of reliable data concerning China's metallic mineral resources and mining industry is a problem, not just for researchers outside China, but also for Chinese researchers. Great effort is required for even modest success at updating and expanding the available data banks. Confidentiality requirements are one handicap, and the lack of a fully developed statistical system suitable for both major and countless small-scale operations is another. This study seeks to compare and supplement accessible public sources with personal experience and judgement. In this way, the researcher hopes to clarify some basic aspects of China's metal mining industry, and to present a logical analysis of its problems and potential.

Major Findings

China's metal mining sector and mineral trade are firmly linked to its overall social and economic background. Shifts in both its domestic circumstances and the global context surrounding China will impose a course of change upon this ancient nation in the near future. It is suggested that a realistic and long-term view of China's developing economy should be adopted.

China's industrial structure is basically diversified, with its relatively well-developed manufacturing sector leading the process of economic and industrial modernization. After rapid acceleration in development, overheating of the economy occurred in the 1980s, fuelled by a fundamental inadequacy in raw material supply from the primary industries. Raw material shortages derived from capital scarcity, low priority for resource development, weak infrastructure, inadequate mining and exploration regulations, and low productivity. As a result, in the mid-1980s China become a major importer of metals and ore concentrates.

China is particularly short of base metals. Current state austerity measures for reducing social demand will provide only temporary relief. They cannot hold demand in check for the long term. Nor can they eliminate the shortage of supply, or the difficulties caused by the fundamental weakness of the energy and mining industries relative to (and required to support) the well-developed capabilities for construction and manufacturing.

China's mining sector has been weak for a long period, and has numerous deep-seated problems. A

rapid increase in mineral production will require many mineral-specific incentives to redirect and attract much-needed investment, and other such measures, in conjunction with overall economic reform. Examples of the sorts of mineral-specific problem-solving required include the following.

Geological Surveys and Exploration

The present geological survey operating budgets are inadequate due to excessive numbers of technical workers and enormous administrative staffs in the central and provincial geological agencies. China needs more mineral exploration as a foundation for expansion of its mineral resources, but the geological service is not efficient or productive. In addition to staff reductions and administrative reform, it is necessary to increase the financial resources of the geological surveys by looking beyond government funding. For example, regulations should be instituted to require mining companies to repay the expenses for geological exploration leading to mine development. Payment should also be made by private-sector users for geological data and for geological services.

Legislative and Industrial Problems

China's economic legislation and regulations were constituted mainly for the benefit of the manufacturing sector. They must be broadened to accommodate the needs and concerns of the mining industry. The key means for strengthening and sustaining the metal mining industry lies in the formation of a distinctive and workable industrial policy, to permit orderly movement towards a freer-enterprise management. At the same time, the countless small and unlicensed mining operations must be brought under control through a revised mining code and regulations. These changes will require fundamental modification in attitude and management, as well as in regulatory structures.

Industrial Restructuring

Metal producers must wean themselves step-by-step from state departmental "parenting", and establish themselves as mature, independent, market-oriented entities. Any success that metal mining in China may have enjoyed in past years has revealed the advantages of letting mining enterprises function as independent entities, capable of recognizing and responding to opportunity and with full responsibility for their own decisions. This transformation will require economic and administrative reform.

Revenue Generation and Sharing

A long-term plan for revenue generation and sharing, and for the rational use of mineral resources, needs to be established, with the following aims:

- enforcement of the Mineral Resource Law and its principle of public sovereignty over mineral resources;
- licensing of exploration and mining to prevent wasteful exploitation of resources;
- reform of the price-royalty-taxation system to make the domestic price level of raw materials more realistic, relative to that of finished products;
- development of a system of incentives and penalties to encourage the highest possible recovery of non-renewable mineral resources and the discouragement of wasteful mining activities.

Price Reform

For decades, until the end of the 1980s, China's mining sector suffered under an artificial system of prices, far below world market prices for most metal ore concentrates. In the mid-1980s, a secondary system of parallel market prices was introduced, allowing higher prices for commodities produced beyond the state requirements. This dual-price system has complicated the material supply situation and worsened general economic conditions within China, as producers sought to have their output diverted from lower-price state allocations and into the higher-price markets. It also increased the temptation for intermediate traders to smuggle the most valuable products of small mines into the higher-priced market, and encouraged local corrup-

tion. It is crucial to eliminate this peculiar dual-price system as quickly as possible, and then to link domestic prices for metallic minerals more closely to international market levels.

Investment Incentives

Because the ramifications of these artificially low prices are widespread and deep-rooted, it may not be possible to accomplish price reform immediately. This in turn will mean a continued shortage of revenues needed to fund new mineral investment. One solution to this problem would be a targeted investment policy during the transition period, providing incentives and assistance such as long-term loans at low interest rates for some types of mining. In addition, increased capital budget allocations from state funds could be made available to well-managed mining operations.

Mobilization of Domestic Investment

Mobilization of domestic investment for China's primary industries could reinforce the weak sectors. One such source could be a coordinated reform of the existing housing subsidy and of wages. Raising wages would permit elimination of the enormous housing subsidy. With this deep-rooted social and economic reform, an unimaginable increase in housing demand would follow, funded by private earnings and freeing public and private investment funds to invest in raw material industries.

The existing substantial private savings of individuals could also be used to invest in the resource industries, rather than fuelling panic shopping for consumer goods, if an effective financial system and stable social confidence can be created. The experience of the Shanghai Petro-chemical Corporation has demonstrated high interest on the part of local residents in becoming shareholders in a resource industry. The potential financial resources of the population are enormous, given the appropriate environment and opportunities through social and economic reform.

Foreign Investment

International investors have encountered difficulties and complications in drawing up and implementing contracts with Chinese partners in the past. Although much of the problem can be attributed to China's business practices and customs, the author suggests that difficulties on the part of Westerners in understanding Chinese business practices and institutional constraints were also a factor hampering mutual cooperation. Perhaps more active bilateral contacts and joint advisory agencies, as well as studies such as this, will be helpful in the future.

2. China's Current Economy

Some basic demographic and economic information about China is presented in Table 1. It is clear that China is a large, heavily populated country, with low per-capita production value and a trade deficit problem. (See also Table 2.)

Table 1. China: 1987-88 summary statistics

	1987	1988
Area (000 sq km)	9,600	9,600
Population (million)	1,080	1,096
Population/sq km	113	114
GNP		
Yuan billion, current	1,138	1,459
US$ billion	305.9	392.2
Mining sector (Yuan billion, current)	75.7	87.4
As % of GNP	6.65	5.99
GDP/Capital (US$)	83.3	357.9
Exports as % of GDP	12.9	12.1
Imports as % of GDP	7.0	14.1
Imports of metals & concentrates (US$)	4.9	4.9
As % of total imports	11.3	8.9
Official exchange rate (Yuan/US$)	3.72	3.72

From the 1950s to the 1970s, however, China's domestic economy had been almost self-sufficient. Average annual GNP growth rate was 8.6 percent over the period 1953-78. In 1978, the new policy of encouraging economic growth by motivating domestic business and by opening the door to foreign trade led to an increase in the annual growth rate to an average of 10 percent during the period 1979-87. Since rapid development of the economy was a major goal in that dynamic time, it was plain that any labour-intensive business with low capital requirements which could contribute to increased domestic or export earnings and to improved living standards was a leading target of opportunity. Industrial and construction activity increased significantly, as shown in Table 2. To support this development, the energy and transportation sectors were given top priority in the development strategy. The basic materials sector, especially metal mining, was given lower priority in government plans, including plans for investment allocation and production levels.

An increase in imports of metals and combined with the unexpected drop in oil prices after 1985-86 caused a significant national trade deficit for China, and made this dependence on metal imports a difficult course to continue. Table 3 illustrates the import-export balance of the country in 1987-88.

Prior to 1985, when oil prices were high, China exported 20 to 30 million tonnes of crude and refined oil yearly, nearly sufficient to compensate for the expenses of metal imports.

After a decade of economic reform and development, an austerity policy was initiated in late 1989 to try to tame the resulting runaway economic growth and solve the related social problems. These austerity measures showed only limited results in their first year. In addition to new difficulties arising from the measures themselves, or created by various other dilemmas, 1989-90 economic reports in China expressed continuing concern at the weakness of the primary industries, relative to the better-developed capabilities of manufacturing and construction.

Finished steel supply declined by 600 thousand tonnes in the first quarter of 1990 compared to the same period of 1989, largely as the result of a shortage of raw materials and energy. Copper and zinc were in especially short supply, due to higher world prices for metals and China's reduced ability to pay for imports. Annual steel imports decreased by 625 thousand tonnes over 1989 level. Silicon plates, cold-rolled plates, oil pipes, and heavy and light rails were in especially short supply. The shortage of fuel and fertilizers for agriculture and the scarcity of electricity and base metals for urban areas, compounded with inadequate economic regulation, have created problems in many of the government agencies responsible for running the various industrial sectors.

Table 2. Major measures of China's economy, seclected years, 1978-89 (current price)

Measures	Units	1978	1980	1985	1986	1987	1988	1989
Poplulation	persons*	963	987	1,050	1,065	1,081	1,096	1,112
Employees	persons*	95	104	124	128	132	136	137
GNP	Yuan**	348	434	833	946	1,138	1,459	1,568
Agriculture	Yuan**	140	192	362	401	468	562	655
Mining	Yuan**	na	na	na	57.8	68.1	75.7	87.4
Construction	Yuan**	57	77	166	204	243	297	283
Industries	Yuan**	424	516	972	1,119	1,381	1,810	2,188
Investment	Yuan**	na	91	254	302	364	431	400
Retail trade	Yuan**	156	214	431	495	582	744	810
Foreign trade	US$**	20.7	37.9	69.6	73.8	82.6	102.8	111.6
Exports	US$**	9.8	18.3	27.3	30.9	39.4	47.5	52.5
Imports	US$**	10.9	19.6	42.3	42.9	43.2	55.3	59.1
Current account balance	US$**	-1.1	-1.3	-15.0	-12.0	-3.8	-7.8	-6.6
Retail index	1952=100	122	131	156	165	177	185	178
Salary total	Yuan**	57	77	138	166	188	232	264
Annual individual income	Yuan**	615	762	1,148	1,329	1,456	1,747	1,935

Source: *Social and Economic Statistic Yearbook*, Statistic Bureau China, 1988/89/90, Tables 2-3; Economic and Social Statistic Bulletin, 1988/89, Statistic Bureau China.

Note: * hundred thousand
** billion

As some economists had warned, a major failure in the Chinese industrial strategy of the 1980s was the undue emphasis placed on growth of social consumption, construction and manufacturing, far beyond the capability of the agriculture and mining sector to support them. Sooner or later, a slowing of the economic growth was inevitable. Although this topic is far beyond the scope of the present study, it is important to note that this slow-down in the growth rate was partly due to shortages (and to smuggling outside of official markets) of raw materials.

By the end of the decade, economic agencies began to recognize that the agriculture and mining sectors are the foundation of China's economy, and that both must be given priority. More investment, lower-interest loans, and higher product prices have been promised to the primary sectors, but it will take several years to achieve positive results. Because the current economic policy in China is too rigid to deal effectively with the substantial difficulties that have accumulated over the last decade, China's metal mining industry will continue to be weak, and China will remain a nonferrous-importing country at least until the year 2000.

Structure and Management of the Chinese Economy

China has a centralized system of state administration, with three direct-subordinate cities, twenty-three provinces and four autonomous regions, each with its own local government and areas of jurisdiction. The central government with its state ministries is located in Beijing. It has leading authority over the implementation of economic laws and the formation of current and long-term economic policies and plans. The main role of both central and local governments, in addition to political and administrative functions, is general eco-

Table 3. China: 1987-88 major exports and imports (value in US$ million)

Items	Units[a]	1987		1988	
		Quantity	Value	Quantity	Value
Exports					
Sea products	thousand tonne	218.21	702.59	287.23	932.85
Tea	thousand tonne	174.28	362.49	198.29	401.97
Cans	thousand tonne	536.97	535.95	556.73	641.03
Coal	million tonne	13.53	476.33	15.65	514.95
Crude oil	million tonne	27.23	3,140.97	26.05	2,579.64
Refined oil	million tonne	4.97	764.22	4.79	681.45
Spindles	thousand tonne	242.82	535.11	205.72	511.77
Cotton cloths	thousand metre	234.15	1,525.25	222.94	1,487.75
Polyester-cotton cloths	thousand metre	114.74	632.34	103.80	620.12
Natural silk	thousand metre	15.04	459.03	20.99	680.71
Clothing	thousand unit	116.86	2,605.75	157.33	3,405.09
Other		..	..	..	..
Total			39,437.00		47,540.00
Imports					
Grain	million tonne	16.28	1,754.02	15.33	1,895.54
Lumber	million metre[3]	6.46	529.10	10.47	1,052.96
Pulp	thousand tonne	683.34	370.19	795.09	529.95
Wool	thousand tonne	151.29	538.28	187.38	895.54
Fertilizers	million tonne	10.90	1,399.23	14.71	2,335.49
Plastics	thousand tonne	1,127.95	1,027.33	2,084.75	1,840.96
Finished steels	million tonne	12.40	4,461.96	9.13	4,430.10
Steel wires	thousand tonne	52.18	41.03	19.03	19.09
Copper & alloys	thousand tonne	75.48	112.39	84.37	191.26
Aluminum & alloys	thousand tonne	184.13	229.83	75.38	174.78
Zinc & alloys	thousand tonne	68.15	56.26	61.99	63.31
Vehicles	thousand unit	90.24	970.39	94.70	1,066.40
Vehicle parts			259.62		339.10
Ships	unit	955	148.80	6,067	198.53
Other		..	..	..	..
Total			43,216.00		55,251.00
Surplus/Deficit			-3,779.00		-7,711.00

Sources: *China's Statistic Yearbook*, 1989, Statistic Bureau China, Tables 12-5, 12-6.
[a] Units of measures used in this report are exclusively metric.

nomic control. Central planning is the dominant factor in managing China's economy. Jurisdiction over mining and mineral-related activities is divided among at least five ministries, as shown in Table 4.

There are three types of ownership of economic activities in China: state or public ownership, collective, and private. Most of its natural resource industries and enterprises fall into the category of public or collective ownership. Private ownership has been developing slowly in recent years, but private companies are very small units and a small part of the total. Enterprises with both collective and private ownership are permitted to run their businesses and investments in agriculture, mining, manufacturing and construction outside of and separately from the central plan. However, government economic agencies may influence collective and private economic activities through various indirect and market mechanisms.

Table 4. China: mineral-related state agencies and activities

Ministries & agencies	Principal mineral-related activities[a]
Ministry of Geology & Mineral Resources	Prospecting, exploration and evaluation of mineral resources in of mineral potential
Ministry of Oil and Natural Gas	Prospecting, exploration and exploitation of oil and gas fields Petro-chemical engineering
Ministry of Coal	Prospecting, exploration and exploitation of coal fields Coal processing
Ministry of Metallurgical Industry	Prospecting, exploration and exploitation of resources needed for iron and steel production Iron and manganese ore processing and smelting Rolling steel
China's Natural Nonferrous Metal Corporation	Prospecting, exploration & exploitation of nonferrous metal resources Nonferrous metal ore processing & smelting Nonferrous metals fabricating

[a] Formulation and implementation of sectoral laws, policies and development strategy propositions are included in responsibilities of each ministry and agency.

Note: In addition, the State Bureau of Building Materials and Industrial Minerals, the Ministry of Chemical Industry and the Ministry of Light Industry have functions appropriate to the minerals they administer.

Economic reform has led increasingly to overlapping areas of jurisdiction among the central government, provinces and municipalities. This has been particularly true since the early 1980s in instances where mining rights were not clearly defined, and where confrontation between the newly emerging local small mines and the older and larger state-run mines has resulted.

Relations among various ministries of the central government, as the senior representatives of public ownership, are in need of rationalization and clarification. For instance, the Ministry of Geology and Mineral Resources is the senior agency with responsibility for prospecting and mineral exploration. However, its jurisdiction overlaps with that of other ministries which, due to their responsibility for existing mines, are also responsible for exploration in their immediate area. Clarification is needed, not only in a geographical sense, but also with respect to sharing the state exploration budget.

Those ministries which manage mines have integrated their mineral extraction activities with raw material processing and material fabrication facilities. Most major metallurgical corporations are vertically integrated, with their own mines, ore processing plants, smelters and metal fabricating works, and with consolidated financial statements. One unfortunate result of the consolidated financial statements is the difficulty in obtaining separate financial information for various stages of the total mineral production cycle in China, such as exploration, mining, milling, smelting and refining, and fabricating.

Investment

The central budget controls allocation of the vast majority of all investment in China, in the form of investment funds for state-run projects. Municipalities have limited but increasing responsibilities for directing local investment funds. All central, provincial and municipal government funds come from taxation and from the profits of publicly owned

enterprises. State-owned enterprises are not permitted to reinvest their own profits, except as set out in the official plans and budgets. Thus, development of the national economy is heavily determined by the state and municipal budgets, with primary control vested in the Investment Bureau of the State Planning Committee. Collective and private enterprises direct their investment independently. This represents a relatively small but growing amount. Private investment, for example, accounted for about 19 percent of total investment in 1981 and 22 percent in 1987.

The level of investment, shown by type of ownership and by financial source, is presented in Table 5. Table 6 shows investment by economic sector in 1987. It indicates the relatively small investment in the ferrous and nonferrous metal mining: only 1.09 percent of total investment in 1987.

Table 5. China: investment by ownership, type of investment and source of funds in selected years (Yuan million, current)

Category	1981	1984	1987
A. Ownership Type:			
State-owned:			
Total	66,751	118,518	229,799
Capital investment	44,291	74,315	134,310[a]
Innovations & reconstructions	19,530	30,928	75,859
Other investments	2,930	13,275	19,630
Collectives:	11,524	23,869	54,701
Urban areas	3,157	6,386	18,130
Rural areas	8,367	17,483	36,571
Private	17,826	40,900	79,586
B. Sources:			
State budget	26,976	42,100	47,554
Domestic loans	12,200	25,847	83,594
Foreign sources	3,636	7,066	17,537
Reinvestment & etc	53,289	108,274	215,401
Total investment	96,101	183,287	364,086

Sources: *China's Statistic Yearbook*, 1988. Statistic Bureau of China, Table 10-1.

[a] This element is exposed in detail by Table 6.

Table 6. China: capital investments in 1987

Sectors	Yuan million	Percent
Agriculture	4,211	3.14
Forestry	437	0.33
Cattle breeding	205	0.15
Fishery	220	0.16
Hydro-engineering	2,118	1.58
Industries	68,279	50.83
Geological survey	733	0.55
Mining	12,294	9.15
Coal	5,961	4.44
Oil & gas	4,222	3.14
Ferrous metals	645	0.48
Nonferrous metals	825	0.61
Nonmetallic materials	526	0.39
Salts	108	0.08
Electrical power	20,865	15.53
Chemical industry	7,885	5.87
Coking	1,103	0.82
Iron & steel metallurgy	4,580	3.41
Nonferrous metal metallury	1,877	1.40
Metal fabricating	248	0.18
Machinery	1,645	1.22
Transportation equipment	1,805	1.34
Other industries	6,488	4.83
Construction	1,543	1.15
Transport & communication	18,973	14.13
Commerce & storage	4,776	3.55
Real estate manage, public utilities & information services	9,257	6.89
Health & welfare	2,857	2.13
Education, culture & broadcasting	9,699	7.22
Scientific research & technological services	2,644	1.97
Monetary & insurance	1,318	0.98
Other sectors	7,749	5.77
Total	134,310	100.00

Sources: *China's Statistic Yearbook*, 1988. Table 10-17. Statistic Bureau China.

Market and Prices

In China's centrally planned economy, transactions involving materials, services and financial exchanges among state-owned enterprises occur entirely within the context of mandatory allocation and arbitrarily set prices. Real market-oriented economic activities occur only between

- state retail sellers and individual customers;
- state retail sellers and collective or private enterprises, including agriculture producers;
- collective and private enterprises with each other;
- collective and private enterprises and their individual customers.

These market-oriented transactions are based on prices negotiated by the principals in the transaction, but even these prices are influenced or controlled to some extent by State or Municipal Price Committees.

Economic reform over the last decade has allowed some enterprises to be involved in market-oriented activities, but only when their mandatory production quotas and allocations have been met. This has proven difficult to administer in practice, particularly because of the higher prices prevailing in the market.

Retail price indices for 1978-89 were presented in Table 2, which shows an increase of 78 percent over this 11-year period. The scale of retail market activities in China is shown in Table 7, for two recent years. A few examples of the sharp increases in retail prices for some basic commodities from 1987 to 1988 are shown in Table 8.

Among the reasons for the severe inflation (18.4 percent) in this interval were extreme shortages of supply, notably of copper and aluminum, increased smuggling, and panic shopping. The cost of living index increased by about 20.7 percent; this caused vigorous social discontent.

It is impossible to estimate what proportion of the metallic and other commodities traded in 1988-89 was sold at mandated prices, and what proportion sold on the free market. One of the problems in measurement is the fact that some of the mandatory allocations were smuggled into the free market to take advantage of the higher prices. Such illegal action on the part of state agencies has been termed "official smuggling".

Table 7. China: 1987-88 retail market transactions (billion Yuan, current)

	1987	1988	Increase in %
Total	582.16	744.00	27.8
Agriculture necessity	70.51	89.90	27.5
Other retail consumption	511.42	654.10	27.9

Sources: Statistic Report of Social and Economic Redevelopment of People's Republic of China, 1988. Statistic Bureau China, February 28, 1989.

Table 8. Selected commodity prices

	Price (Yuan per tonne)		
Commodities	1987	1988	Increase in %
Grain	442.0	455.8	8
Salt	360.2	432.2	20
Copper	8,500.0	17,000.0	50
Aluminum	15,000.0	21,000.0	39

Sources: Statistic Report of Social and Economic Development of People's Republic of China, 1988. Statistic Bureau China, February 28, 1989.

In order to support selected top-priority construction and manufacturing projects late in 1989, the state began to control a large part of the non-ferrous metals supply, which had previously been outside the central planning arrangement for metals. Exports of aluminum were banned in an attempt to relieve long-term domestic shortages. Under pressure from high world prices, China's mandatory price for aluminum rose in several steps in 1989, and climbed again from Yuan 13,000 to 16,000 per tonne in April, 1990. Some domestic uses of copper were restricted, as well; for example, it was forbidden to use this metal for producing locks, keys, mirror frames, compasses and scales. In the summer of 1990, the compulsory ceiling price of electrolytic copper increased from Yuan 16,000 to 18,500 per tonne, and it rose again from Yuan 17,000 to a high of 22,000 by April 1990.[2] These price rises reflected increasing production costs as well as shortages. For crude steel, for example, costs increased

[2] *China's Economic News*, Jan. 26, 1990; Feb. 14, 16, 19, 1990; *Economic Information*, Apr. 19, 1990. (Most information comes from Chinese publications, except where otherwise noted.)

from Yuan 550 to 720 per tonne during 1990, and costs for cast iron increased from Yuan 600 to 780 per tonne.

In contrast, domestic demand for metals decreased in the early 1990, and the free-market prices for metals have fallen. In the first quarter, the consumption of finished metals declined as follows: steel 8.6 percent, copper 5.3 percent, and aluminum 14 percent. Their domestic[3] market prices also declined significantly. Although total consumption in 1990 of nonferrous metals was reported to be about the same as in 1989, demand for lead and tin was less than the annual production. Due to the decline in demand, the market price per tonne for aluminum dropped from Yuan 21,000 in 1988 to 12,000 in early April 1990. This was the first time the market price of aluminum had fallen below the mandatory norm of Yuan 16,000. The market price of nickel dropped from Yuan 130,000 in 1989 to 75,000 per tonne. Obviously, the mandatory austerity policy had a severe impact on the market-oriented sector of the economy.

Although the government claimed that the general situation had improved by the second quarter of 1990, metal markets did not share in any improvement. For example, there was a surplus of finished steel, as the demand for durable goods was weak, and market prices for steel in April fell below those in March. Increasing inventory, coupled with declining retail sales in 1990, had a negative effect on income, employment, state revenues, productivity, and the level of capital investment.

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[3] Since this report concerns China's mining sector, all information given hereafter refers to China's domestic situation and not to world markets, unless otherwise noted.

3. Overview of China's Metal Mining Industry

Introduction

China has rich reserves of tungsten and antimony, about half of known world reserves according to Crowson's figures shown in Table 9. It also has significant reserves of a number of other metals. Table 9 also indicates some of the data problems encountered in studying the Chinese mineral sector, as does Table 10, which gives US and Chinese estimates of resources on a per-capita basis.

In this chapter, and throughout this study, the author relied mainly on Chinese sources, supplemented by personal sources and observations. There are significant differences in some cases from the figures found in Western sources. This study makes no attempt to reconcile these differences.

Iron

At the end of 1988, the generally agreed figures for guaranteed iron ore reserves were as follows: proven and probable, 49.6 billion tonnes; developed, to be developed and projected, 25.7 billion tonnes or 51.8 percent of proven and probable reserves. There were no plans to develop 23.9 billion tonnes or 48.2 percent of these proven and probable resources, however, because their low quality or remote location placed them outside existing or planned mining areas. The average grade of extracted iron ore was low, at 33 percent metal concentration. Almost all of these ores, 97.7 percent, must be processed and enriched.[4]

Iron ores are found in the following provinces or regions:[5] Liaoning, Sichuan, Hebei, Shanxi, Anhui, Hubei, Yunnan, Shandun, Inner Mongolia, Henan and Guandung. Of the total discovered iron ore reserves, 51.3 percent are clustered in three areas:

- North China's iron and steel base, Hebei province, contains ample iron ore resources estimated up to 6 billion tonnes;
- Anshan-Benshi iron and steel base, Liaoning province, has sufficient local resources. Nanfen, Chidashan, Dun'anshan and Xi'anshan mining operations are to be enlarged or developed;
- Panzhihua Iron and Steel Corporation, Sichuan province, has a plentiful supply of local iron ores.

Manganese

The 500 million tonnes of manganese resources are evenly distributed geographically. The carbonate type comprises 56 percent. The average concentration of manganese in these resources is low, at 22 percent. High-grade metallurgical ores are scarce: only about 10 percent have a manganese concentration higher than 30 percent. All proven reserves contain noticeable quantities of phosphorus and sulphur. With these sorts of ore, it is important to improve the technology of their dressing and smelting.[6]

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[4] Wu Kecheng: Analysis of China's iron ore resources and some suggestions, *Geological Economy of China*, No. 10, 1989, pp. 17-21.

[5] A general geographical distribution of China's mineral resources has been demonstrated in the maps of the report, *The Mineral Industry of China* (Statistics and Location), A. Werner, Energy, Mines and Resources Canada, Ottawa, 1988.

[6] Wei Lianghong and Zhou Wenqin, "China's manganese production and strategy of its development", *Geological Economy of China*, No. 9, 1989, pp. 13-16.

Table 9. Metallic mineral reserves (million tonnes contained metal unless otherwise specified)

	Crowson			Chinese Sources
	World (volume)	China (volume)	China (as % of world)	China (volume)
Antimony	4.2	2.3	52.0	8.7
Bauxite	20954.0	150.0	0.7	1,480
Copper	337.0	n.a.		19.5
Gold (thousand tonnes)	39.8	n.a.		2.1
Iron (billion tonnes)	65.7	3.2	4.9	25.7
Lead	96.0	2.0	2.1	10.5
Manganese	929.0	14.0	1.5	50
Nickel	53.0	0.7	1.4	4.5
Tin	3.1	0.08	42.9	2.1
Tungsten	2.8	1.2	3.0	1.5
Zinc	169.0	5.0		24.5

Sources: Phillips Crowson, *Minerals Handbook 1986-87*, N.Y.; Stockton Press, 1987.
Chinese sources are calculated from Table 10 (where figures are identified as resources rather than reserves) or taken from the reserve figures given in the following text.

Table 10. Estimates of per-capita metallic mineral resources

Resources	World	China	China as % of World
Antimony (kg)	7.1	7.9	111.3
Bauxite (tonnes)	4.2	1.3	30.9
Copper (kg)	118.0	45.5	38.6
Gold (gram)	10.0	1.9	19.0
Iron (metal, tonnes)	24.0	8.2	34.2
Lead (kg)	30.2	9.5	31.4
Manganese (tonnes)	3.1	0.5	16.1
Nickel (kg)	14.2	4.1	29.0
Tin (kg)	2.3	1.9	82.6
Tungsten (kg)	0.9	1.4	155.5
Zinc (kg)	43.3	22.3	51.5

Source: *World Mineral Facts and Problems*, U.S. Bureau of Mines, 1980; *China's Year 2000*, Research Centre of China's State Council, 1986; *Social and Economic Statistic Yearbooks*, Statistic Bureau China, 1982 and 1988.
Note: At the end of 1989, China's population of 1.1 billion represented 22 percent of total world population.

Deposits of oxide ore of manganese are broadly scattered in the southern provinces, and are extracted mostly by nonmechanized manual labour. Most proven reserves are in the Guanxi autonomous region, and in Hunan and Guizhou provinces.

In the Guanxi region, Daxin-Xalei is the largest deposit with 16.8 percent of China's reserves, followed by Muguei and Luntou; 2.4 percent and 34.5 percent of local reserves are dry-cell and oxide sorts, respectively.

In Hunan province, the principal deposits are Xanten, Taojian, Huaihua and Houjanchau. Huaihuan is a large undeveloped deposit with a high phosphorus concentration. Ore from the Houjanchau deposit of Dao county has been extracted for 80 years, but only 32 percent of its reserves have been developed. Hunan province produces 35 to 40 percent of China's manganese ore.

Guizhou province contains the notable Zunyi mining area. Its annual projected capacity is 600,000 tonnes. Recent annual production has been in the order of 150,000 tonnes. Even larger is the undeveloped Datanpu deposit, with immense resources of high phosphorus content; this deposit is an extension of the Huaihua deposit of Hunan province.

In the adjoining areas of Sichuan, Guichou and Hunan provinces, including Shoushan, Suntao and Huahuan counties, there is a promising area with manganese resources estimated at over 300 million tonnes, still to be explored and developed.

Shenxi province has the newly discovered Ziyan-Zhenba manganese deposit, with good-quality ores and possible reserves of 2 million tonnes.

Copper

There are approximately 55.7 million tonnes of copper metal reserves. However, 40 percent are in ores of the low-grade porphyry type and most are located in the remote areas of Heilujian province, Inner Mongolia and the Qinhai-Tibet plateau. Only 35 percent of these reserves have a copper concentration over one percent; six percent of reserves have a copper concentration over two percent.[7]

[7] Jiang Shuxing: The state of China's copper resources – analysis and suggestions. *Geological Economy of China*, No. 8, 1990, pp. 21-25, and Lee Zhifun: Some opinions on the strategy of developing China's copper industry, *Geological Economy of China*, No. 9, pp. 10-12.

The geographical distribution of copper reserves is as follows:

- 34.3 percent in the Lower Yangzi river valley, including Dexing, Yunpin, Wushan, Dungshan, Yinshan and Chenmenshan of North-East Jianxi province, Tunglushan of Hubei province, and the Tunguanshan of Anhui province;
- 14.3 percent in South-West China, including Dungchuan and Yimen of Yunnan province and the Xichan district of Sichuan province; 7.4 percent in Beiyinchan of Gansu province;
- 5.9 percent in Zhuntiao of Shanxi province;
- 15.1 percent in the Qinhai-Tibet plateau;
- 23 percent in Duobaoshan of Heilunjian province, Bainaimiau of Inner Mongolia and De'erni deposit of Qinhai province.

Dexing area (Tungchan and Fujiawu deposits) has 1.52 billion tonnes of ore reserves containing 7.44 million tonnes of copper, 240.6 tonnes of gold, 2,831 tonnes of silver and 282 thousand tonnes of molybdenum. In this area, developed reserves are 38 percent, and reserves to be developed are 18 percent. The rest are in the difficult-to-develop category.[8]

Bauxite

Two hundred and six bauxite deposits have been discovered in eighteen provinces. Reserves of 1.48 billion tonnes had been identified by 1988, which placed China in fifth position with regard to world bauxite reserves, according to Chinese estimates.

China's bauxite resources may be characterized as follows:

- Geographical concentration: 88 percent of bauxite resources are in Shanxi, Henan, Guizhou, and Shantung provinces and the Guanxi autonomous region and are within coal basins or located near hydro-electrical power centres.

[8] Xu Jinpeng: Dexing, first mine in the ancient bronze state, *Economic Information*, April 14, 1990.

- Composition: they have high concentrations of aluminum trioxide and iron;
- Grade: 73 percent of reserves have an alumina/-silica content below 7 percent;
- Type: 90 percent of the reserves are of the monohydrate diaspora variety.

Although the monohydrate ore is more complicated to process than the trihydrate, a domestic Sintering-Bayer Combined Alumina Treatment Technology has been developed, and can produce alumina more cheaply than the cost of importing it.[9]

Lead and Zinc

With regard to lead resources, China is fifth after the U.S., U.S.S.R., Canada and Australia. Lead-zinc deposits are found in 26 provinces, but 76 percent of those reserves are in Yunnan, Hunan, Guandung, Gansu, Jianxi and Sichuan provinces, Inner Mongolia and the Guanxi regions.[10] Specifically, they are

- the Lanping deposit of Yunnan province;
- the Taolin and Shuekoushan deposits of Hunan province;
- the Fankou and Dabaoshan deposits of Guandung province;
- the Dachan deposit of Guanxi region;
- the Dunshenmiao deposit of Inner Mongolia;
- the Qibaoshan and Lengshuikeng deposits of Jianxi province;
- the Xitieshan deposit of Qinhai province;
- the Changba, the leading deposit of Xihe-Chenxien lead-zinc zone in Gansu province;
- the Baiyu, Huili and Huidung deposits of Sichuan province;
- the East and West lead zones of Guizhou province.

In the early 1980s, lead reserves were 10.5 million tonnes and zinc reserves were 24.5 million tonnes.

Nickel

Table 10 indicates that China's nickel reserves are only 30 percent of world average in per-capita terms, although in absolute terms its nickel reserve holdings are immense. The Jinchuan deposit of Gansu province is of global importance, followed in size by the Hunqilin deposit of Jilin province. Some smaller nickel deposits have been identified in Shenxi and Sichuan provinces.

Tungsten

China's tungsten reserves are estimated by Chinese geologists to exceed those reported for the rest of the world. Table 10 shows that Chinese estimates of per capita resources equal 156 percent of the U.S. Bureau of Mines estimates of world average. Known deposits are concentrated in adjoining areas of Jianxi, Guandung and Hunan provinces. The major deposits are the Xihuashan, Guimeishan, Pangushan and Dajishan deposits of Jianxi province, Shizhuyuan of Hunan province and Dabanken of Guandung province.

Molybdenum

The leading operating deposit is Jindueichen of Shenxi province, followed by Yanjiazhanzi of Liaoning province. Although the average concentration of metal in ores is low, the ease of extraction condition and low labour costs make China a competitive exporter of molybdenum products.

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[9] Li Yingzhang: An essential analysis of aluminum resources, *Geological Economy of China*, No. 12, 1989, pp. 6-10.

[10] Chinese Academy of Social Sciences: The development strategy for China's primary material industry, Chinese Academy of Social Sciences, 1989.

Antimony

The Xikuanshan antimony deposit of Hunan province is unique in the world, and is the principal reason for China's leading position in reserves, with over half of the world total. Other antimony deposits are located in Guizhou, Yunnan and Gansu provinces and the Guanxi region.

Tin

More than half of the proven reserves in China are located in Gejiu of Yunnan province and Dachan of the Guanxi region. After a century of mining, most of the placer resources have been exhausted. Although the remaining original sulphide ores are more expensive to extract, China is still a important producer and exporter of tin.

China's Mineral Resource Law

Despite the fact that the Temporary Mining Bill of the People Republic of China, issued in 1950, declared public ownership of mineral resources and introduced licensing for resource exploration and mining, there were no strong responsible agencies to enforce this legislation until the late 1980s. This lack of direction became a problem, given the boom in small mining in the early 1980s. The Constitutional Act of Mineral Resource was enacted by The People's Congress, somewhat belatedly in March 1986, and became the effective mining code in October of the same year. This Act reaffirms the state ownership of mineral resources, asserts that mineral resources in the ground belong to the state, not to the owners or possessors of the surface land, and that the state and provincial geological agencies ultimately control the methods of development of these resources. Some key provisions of the Act may be summarized as follows:

- it declares public sovereignty over mineral resources;
- the authorized activities of state-owned mining operations are protected;
- private collective mining and mining activities performed by individuals are encouraged;
- mineral resource exploration and mining activities are to be permitted exclusively under licensing regulation;
- extraction of mineral resources is to be permitted only after a complete feasibility investigation, and proof of intentions for intensive utilization of all mineral components;
- royalties, mining taxes and compensation charges for both the use of resources and the expenses of exploration were introduced;
- central and local geological agencies were given the authority to control and manage mineral exploration and mining activities;
- mining operations are to be held responsible for preventing waste of mineral resources and for providing environmental protection during their mining activities.

Four years have passed since the mining code was enacted, but it is still in the process of being implemented. Disputes between the numerous local small mining operations and existing state operations have erupted often. This is partly because municipal authorities have tended to issue mining licences to local small mining operations and cooperatives without due regard for existing mines, or without defining exact boundaries for their mining activity.

Iron and Steel Sector

In recent years, China has become the world's fourth largest iron and steel producer. Its crude steel output in 1988 and 1989 was 59.4 and 61.3 million tonnes respectively.[11] The annual output of crude iron ore reached record levels, 154 and 160 million tonnes, in these two years. The growth of crude iron ore production from 1976 to 1988 was 87 percent, far below crude steel growth of 190 percent. Table 11 shows iron and steel production figures for 1980-89, with iron ore production continuing to grow more slowly than crude steel (40 percent and 45 percent respectively).

[11] *Social and Economic Statistic Yearbook*, 1989, Statistic Bureau China, 1989; *People's Daily*, February 22, 1990.

Table 11. China's iron and steel production, 1980-89 (million tons)

Year	Iron ore		Iron	Crude Steel
	Crude	Concentrate		
1980	113	38.9	38.0	37.1
1981	105	35.0	34.2	35.6
1982	107	35.3	35.5	37.2
1983	117	37.6	37.3	40.0
1984	127	41.1	40.0	43.5
1985	137	43.8	43.8	46.8
1986	149	47.1	50.6	52.2
1987	161	52.0	55.0	56.3
1988	154	53.0	57.8	59.4
1989	159	55.4	59.7	61.3

Sources: *Social and Economic Statistic Yearbook*, 1989, Statistic Bureau China; China's Iron and Steel Statistics, Iron and Steel Publisher, 1987/88/89; National annual economic and social statistics bulletin, 1989; *People's Daily*, February 22, 1990.

Nanfen of Liaoning province and Shuechan of Hebei province are the two largest iron mining operations, each with an annual production of crude iron ore of more than 9 million tonnes. Mines with an annual capacity of crude ore over 5 million tonnes are Qidashan, Dun'anshan and Gunchanlin in Liaoning province, and Dashihe in Hebei province. In Baiyun'erbuo, Inner Mongolia, production of iron ore was 5.2 million tonnes in 1989, and is expected to reach 7 million tonnes by 1995. In addition, a new Sijiayin pit is planned in Hebei province and another new pit, Baima, is to be developed in Sichuan province.

Nonferrous Metals Mining

China's nonferrous metal production was quite insignificant in the early 1950s, below 20 thousand tonnes, but rose to over 2 million tonnes by 1989, as shown in Table 12.

China's National Nonferrous Metal Corporation completed 31 major expansion and upgrading projects in the period 1985-89, increasing the nonferrous capacity of the Corporation by 60 percent. This level of investment required an extraordinary focused effort to acquire Yuan 5 billion of the funds available for centrally planned investment.

Table 12. China's nonferrous metal production (thousand tonnes)

Year	Total	Copper	Aluminum	Lead	Zinc
1950	< 20	n.a.	n.a.	n.a.	n.a.
1955	120	n.a.	n.a.	n.a.	n.a.
1979	950	n.a.	n.a.	n.a.	n.a.
1982	1,230	n.a.	n.a.	n.a.	n.a.
1988	2,010	517	718	241	425
1989	2,140	541	750	283	426

Sources: Policy Sector of CNNC: Nonferrous metals industry in 1987/88, Economic management of metals production, 1989, p. 6; Fei Ziwen: Climbing the third peak of nonferrous metals industry, *World Nonferrous Metals Magazine*, No. 1, 1990, pp. 3-9; *China's Nonferrous Metals*, January 7, 1990.

In the period 1980-89, nonferrous metal production increased by 64.8 percent. Individual large-scale mines were updated with domestic and imported equipment that advanced their technology by almost two generations.

This rapid increase in nonferrous metals production also depended significantly on the expansion of the contribution of small mines. To support small mining, a Loan Interest Subsidy Regulation (based on returning part of the interest on outstanding loans) was introduced. The total value of loan-interest subsidies in 1990 was Yuan 10.05 million. In early 1990, a Yuan 200 million low-interest-loan fund was established to support the reconstruction and extension of these mines.

For 1994, the target for all nonferrous metals production is 3 million tonnes, with an annual growth rate for copper of 2.5 percent, for aluminum of 11.9 percent, for lead of 5.4 percent and for zinc of 5 percent.

China's metal mining industry is mainly oriented towards domestic demand, but it also enjoys an important global position in the production and export of tungsten, antimony and rare earths. Since other nonferrous metal production was relatively low and consumption has grown significantly in recent years, dependence on imports has increased continuously since the early 1970s, in spite of growing domestic production. Current production of nonferrous metal concentrates is only half of domestic demand. An optimistic forecast of continuing increases in demand for nonferrous metals in China seems reasonable for the foreseeable future.

Copper

The annual average growth rate of copper production was 6.85 percent during the period 1953-86, but self-sufficiency declined from more than 100 percent to 73.6 percent during this time. To cover consumption of 886 thousand tonnes in 1986, it was necessary to import 234 thousand tonnes of copper in concentrate and metal. Imports have exceeded half a million tonnes annually since 1988. Obviously, such imports cannot be expected to diminish by the year 2000, given predictions of considerable growth in consumption and the impossibility of increasing domestic supply significantly over this period.

There are 85 major and more than 150 small-scale copper mines. According to domestic and foreign estimates, the production of copper in concentrate was 175 thousand tonnes in 1982, 185 thousand tonnes in 1985 and 240 thousand tonnes in 1989.

The most important copper producer is Dexing Corporation, Jianxi province. Its 1989 copper-in-concentrate output was 42,150 tonnes. Daily ore extraction and processing capacity was 30 thousand tonnes. A new, third extension plan is expected to provide for an annual 60 thousand tonne copper-in-concentrate increase by 1992 (30 thousand tonnes by 1990, another 30 thousand tonnes by 1992) so that annual total copper-in-concentrate production will reach 80.7 thousand tonnes. By 1995, plans call for daily extraction and processing capacity to reach 100 thousand tonnes and annual copper-in-concentrate production will reach 140 thousand tonnes. If it reaches these goals, Dexing will become the largest copper producer in Asia, and its annual production of gold will reach 3,650 kg. Annual refined copper production, which amounted to 545,108 tonnes in 1989, is expected to reach 550,000 tonnes by 1990.[12]

In the mid-1980s, several new nonferrous metal processing plants in China were able to repay their investment within a couple of years. This encouraged a number of small-scale enterprises to start up. Unfortunately, total metal processing capacity grew far beyond both metal supply and domestic demand. As a result, a battle broke out between large and small processing plants, for both metals and markets. The sudden shift to the current austere investment policy, combined with lower market demand for durable goods, broke like a storm over this community. The larger plants experienced greater difficulties; because their profiles of production are less flexible and their prices for products were fixed, their energy costs and tax obligations rose much higher.

A policy supporting the extraction of low-grade resources through higher prices is in force in China. However, although the mandatory price for electrolytic copper was raised significantly during the last two years, from Yuan 5,500 in 1988 to 18,500 per tonne in May 1990, it was still below the market price, which rose to Yuan 22,000 by February 1990. These higher prices improve the economics of producing copper even from lower-grade resources. Since January 1, 1990, a preferential ceiling price policy has been in place to encourage extracting lower-grade resources. The producers' ceiling price was set at Yuan 17,670 per tonne; the sellers' ceiling price was set at Yuan 18,500 per tonne, on condition that the produced refined copper be allocated to a state-owned commercial agency.

Defined cut-off norms of low-grade copper ore resources are 0.40 percent copper for open pits and 0.50 percent copper for underground mines.[13] The problem remains that it will not be easy to define what proportion of copper were extracted from these low-grade resources. In addition, the Low-Grade-Ore/Ceiling-Copper-Price combined norm is technical rather than economic; it can not guarantee control of extraction practices or of activities in copper trade.

Aluminum

Production of aluminum on the Chinese mainland began in 1954 with an initial annual capacity of 80 thousand tonnes of bauxite, 35 thousand tonnes of aluminum trioxide, and 20.7 thousand tonnes of electrolytic aluminum.

From 1955 to 1987, annual average percent growth rates of aluminum was 11.2 for production and 17-6 for consumption. Total production over this period was 7.90 million tonnes and consumption was 11.39 million tonnes. Imports amounted to 3.77 million tonnes and exports to 150 thousand tonnes.

[12] *Monetary Times*, March 15, 1990.

[13] Yang Taiziao: Policy encouraging extraction of low-grade copper resources, *China's Nonferrous Metal Review*, February 25, 1990.

During the first decade of this period, 1956-65, the annual average growth rates of aluminum were particularly rapid: production grew by 22.4 percent and consumption by 22.6 percent. In the next decade, 1966-76, the annual average growth rate of production fell to 2.3 percent, and consumption to 7 percent.

The growth rate of aluminum production has continued to taper off, compared to consumption, and the consequence has been continuous growth of imports. As estimated in 1987, the average production cost for aluminum in China was approximately Yuan 3,800 per tonne. This is equivalent to US$1,022, with an official exchange rate of US$1 equalling Yuan 3.72. The real LME price was $1,267 in 1984 and $1,054 in 1985.[14] In other words, although domestic production was more economic than importing, imports continued to rise.

Lead and Zinc

In the 1980s, lead production was increased to a level sufficient to meet domestic consumption. But the predicament of zinc was the inverse: the situation changed from one of self-sufficiency to one of shortage and imports, as a result of an unexpected increase in demand. The production of lead and zinc ores and concentrates has increased considerably since 1984 with the encouragement of small-scale mining. Production of lead and zinc in 1990 was expected to reach 720 thousand tonnes to meet domestic demand for both metals, provided smelting capacity can be expanded accordingly. By the year 2000, China may become one of the world's leading producers of lead and zinc.

Nickel

The major nickel producers in China are the Jinchuan Corporation and the Hungqilin Operation. Jinchuan Nickel-Copper Corporation controls 88 percent of the nickel production and 90 percent of platinum production. Its daily average profit in 1989 was Yuan one million. In the first two months of 1990, its daily average profit increased to Yuan 1.04 million. At this rate, it is expected that Jinchuan Corporation will repay all investment (see below) in the next 3 or 4 years.

Since starting production in 1966, the corporation has produced[15]

nickel	245,000 tonnes,
copper	117,500 tonnes,
cobalt	2,311 tonnes,
platinum	7,075 kg.

Financial results were:

gross products	Yuan 6.8 billion,
submitted profits and taxes	Yuan 3 billion.

With the capacity of its first development phase tapering off, a second round of expansion and construction has begun. It was given first priority nationally with Yuan 1.35-1.5 billion in investment and ten thousand workers, and is scheduled to be completed in 1993. This will result in an increased annual capacity of 20,000 tonnes of nickel and 10,000 tonnes of copper, for a total annual capacity of

nickel	40,000 tonnes,
copper	20,000 tonnes,
cobalt	600 tonnes,
sulphuric acid	400,000 tonnes.

The value of imports of nickel and platinum group metals is expected to fall over the next six years by at least US$300 million, as a result of the increasing production capacity of the Jinchuan Corporation.

Tungsten and Tin

The output of tungsten concentrate has increased greatly, from 35 thousand tonnes in 1983 to 59 thousand tonnes in 1988. The purpose of the expansion is to provide increased material for export, since domestic consumption is only about 15 thousand tonnes. The present (1990) emphasis on world-

[14] Phillip Crowson, *Materials Handbook 1986-87*, N.Y.; Stockton Press, 1986.

[15] Wang Deyung: Nickel capital: Jinchuan. *Science and Technology Daily*, March 22, 1990; *People's Daily*, March 26, 1990.

wide arms control, however, has resulted in a significant decline in the consumption of wolfram products. The price of tungsten concentrate has fallen from Yuan 18,000 in early 1989 to Yuan 14,000 per tonne currently. This has forced a number of small-scale operations to close and others to reduce their production.

Placer tin resources have been dwindling since the 1960s and this has led to a significant decline in production. With a set of supporting measures (including new operations in Guanxi region and new technology for processing the original sulphide ore), tin production began to improve in the early 1980s. However, at that time demand was increasing even more rapidly, and the market price reached Yuan 35-42 thousand while the mandatory price was only Yuan 28.5 thousand per tonne in the late 1980s.

The leading provinces and regions producing tin are Yunnan, Guanxi, Guandung, Jianxi, Hunan and Sichuan. Domestic consumption has increased from 12 thousand tonnes in 1985 to 18 thousand tonnes in 1987 with an annual growth rate of 9.37 percent. China's growing tin consumption is large due to the use of tin alloy in the manufacture of bearing bushes. This consumption could be reduced by switching to a low-tin-aluminum or copper-lead alloy steel tape.

On the other hand, China's tin-sheet production needs to be increased considerably. Annual domestic production is low, at about 60 thousand tonnes, compared to demand at 300-400 thousand tonnes. As a result, while exports of metal tin in 1986 were 72 thousand tonnes and earned US$40 million, imports of tin-sheet were 410 thousand tonnes, at a hard-currency cost of about US$237 million. The same imbalance exists with tin chemicals. Large imports of these down-stream products have led to increased foreign currency requirements.

Metal Recycling

China recycled 3.69 million tonnes of steel scrap in 1988, which was 13.1 percent of crude steel production. That figure is low by world standard, about one quarter of the world level. Consumption of nonferrous metals in 1988 was 2.2 million tonnes, of which recycled metals were 220 thousand tonnes or 10 percent. These low recycling ratios of metals reflect the low price for collecting scrap materials. There are also fewer beverage cans in China to contribute to the recycling process. The recycling level is expected to increase to 400 thousand tonnes or 15 percent of annual consumption by the year 2000.

China's newly formed Secondary Nonferrous Metal Corporation is planning to recycle both domestic and imported nonferrous metal scrap, and to trade its products on internal and world markets. Its current plan is for 10.8 thousand tonnes per year, increasing to 50 thousand tonnes by 1995.[16]

[16] Chinese Academy of Social Sciences: The strategy study of China's primary material industry, Chinese Academy of Social Sciences, 1989.

4. Domestic Production and Foreign Trade

Imports

A general picture of the relation between production and imports, and therefore of domestic self-sufficiency in production (disregarding the negligible effect of storage), is shown in Table 13.

In order to meet growing domestic demand, imports of iron ore and steel were stabilized at 15-20 percent of production in the late 1980s.

Self-sufficiency in nonferrous metals has declined since the mid-1970s, from 78.9 percent in 1971-75 to 75.5 percent in 1976-80 and 69.46 percent in 1981-85. In 1982, the deficit in domestic copper concentrate production was 182 thousand tonnes. Five years later this deficit had increased to 327 thousand tonnes. Current copper mining capacity is half that of copper smelting and only a quarter that of fabrication. Expansion in mining is contained by scarcity of proven reserves and lack of development capital.

From 1981 to 1987 the annual average growth rate of domestic aluminum production was 6.4 percent and of consumption was 9.9 percent. During this interval, production volume totalled 3.42 million tonnes, and consumption was 5.4 million tonnes. The level of self-sufficiency fell to 63.3 percent, requiring annual average imports of 247 thousand tonnes. By 1988, however, domestic capacity for aluminum processing had expanded to 880 thousand tonnes per year, well above the previous combined total of domestic and imported aluminum metal, permitting a sharp drop in imports.

From 1956 to 1965, annual average imports of aluminum were 14 thousand tonnes. By 1970 the level had increased to 53 thousand tonnes. Further increases followed: to 142 thousand tonnes by 1975, and to 184 thousand tonnes by 1980. Table 12 shows that imports peaked in the mid-1980s and dropped sharply by 1988.

Annual imports of high-grade iron ore since 1985 have been about 10 to 13 million tonnes per annum, about US$250 million in value. The preliminary forecast of demand for crude iron ore in the year 2000 is 210 to 220 million tonnes. Domestic production is 170-180 million tonnes. Therefore, a deficit of 40 million tonnes of crude ore or 24 million tonnes high-grade ore per year is foreseen. Further data on China's metallic mineral and metal imports are provided in Table 14.

The high level of imports of nonferrous metals during the period 1982-86 was made possible by the high price of oil, which China exports, and low prices of nonferrous metals on the world market. When oil prices dropped after 1985-86, imports were cut drastically and domestic production of some mineral commodities was expanded, although initially this effort was not sufficient to make up the difference. The result was shortfalls and rising prices outside the official allocation scheme.

China will likely continue to import some ore for the foreseeable future; but what kinds of ores, and how much, should be imported? Although China will not have a surplus in its international metals trade for some time to come, there is still room for its exports to have a significant influence upon world markets. For example, it would be possible to produce an additional 5 to 10 million tonnes of iron ore. A number of iron ore deposits are available for development. The current (March 1990) mandated price for 64 percent iron concentrate is Yuan 73.5 per tonne. The average shipping cost for importing and transporting shipping iron ore is about US$25 per tonne. With an exchange rate of US$1 = Yuan 5.22, that translates to Yuan 130.50 or 178 percent of the domestic price. If the mandated domestic price of iron ore were raised by as little as 20 percent, a number of existing iron mines would be much more profitable and an expansion of production would follow. China could then import less iron ore, and spend more of its scarce foreign currency on importing nonferrous metals or other commodities.

Table 13. China: production and import dependence for selected products and years

	1982	1985	1988
Iron ore (million tonnes)			
Production	41.1	43.8	53.0
Imports	3.7	10.1	10.5
Imports as % of production	9	23	20
Steel (million tonnes)			
Production	37.2	46.8	59.4
Imports	3.9	19.6	9.1
Imports as % of production	11	42	15
Copper (thousand tonnes)			517
Production	n.a.	n.a.	84
Imports	111	356	16
Imports as % of production	n.a.	n.a.	
Aluminum (thousand tonnes)			
Production	n.a.	n.a.	718
Imports	209	488	75
Imports as % of production	n.a.	n.a.	10

Source: Other tables in this report.

Table 14. China's import of metals and related minerals (selected years, in thousand tonnes)

	1980	1982	1984	1986	1988
Shipping iron ore	7,350	3,713	5,960	13,720	10,540
Finished steel	5,006	3,938	13,315	17,400	9,100
Copper & alloys	128	111	254	171	84
Aluminum & alloys	110	209	253	226	75
Zinc & alloys	4.6	114	240	117	62

Sources: *China's Statistic Yearbooks*, 1982, 1989; Statistic Bureau China.

Coking coal products have also been in short supply. China is well endowed with coal resources. There is plenty of scope for increasing coal supplies, both to meet domestic demand and to improve China's trade position on world markets. Unfortunately, there was still a need to import some coking coal in the late 1980s, due to internal problems in mining, and the lack of transportation facilities in the regions of greatest potential. The continuing shortages of metals and coking coal are a serious problem, both for industrial production and for the balance of payments. Major new investments will be needed to overcome this problem.

Exports

In the 1980s, exports of copper, aluminium, zinc and nickel were prohibited in principle, due to domestic shortages. Nevertheless, exports of nonferrous metals increased notably in this period (Table 15). In 1988, the value of these exports amounted to US$1.006 billion. Exports by the two largest trading agencies, the China National Nonferrous Metal Corporation and the China International Metal Trade Limited amounted to US$450 million and US$55.98 million, respectively, in 1989. Among the principal mineral exports were antimony, tungsten, and ferro-silicon, with a total value of US$20 million, and wolfram (tungsten) chemicals at US$5.2 million.

However, the export of unreasonably large quantities of tungsten concentrate was a serious error. Bulk exports started in 1983, with shipments of 23.9 thousand tonnes valued at US$140 million. At that time, the price of wolfram trioxide was US$80-100 per tonne-grade.[17] Exports increased to 27.3 thousand tonnes by 1988, largely as a result of expanded production from small mines. This contributed to a sharp drop in the wolfram trioxide price, to US$52 per tonne-grade. The total value of sales declined to US$97 million, in spite of the increase in volume. The per-tonne price of antimony concentrate also declined from US$3,400 in 1983 to US$1,700 in 1989, for similar reasons.

Tungsten, molybdenum, antimony, rare earths, tin, gold, minor metals and magnesite products will continue to be exported by China. Non-metallic minerals such as graphite, marble, gypsum, clay minerals are in ample supply for export as well. To encourage exports, incentives could be offered, such as low-interest loans to expand and up-grade existing facilities, and to create high-value-added processing plants for industrial minerals.

Current free-market prices of tungsten and wolfram concentrate and processed products are determined in the London, Tokyo and New York metal markets. As the leading source of tungsten and wolfram, China could benefit much more from exporting these and other resources in more highly processed form if it could produce such products competitively and if it followed a sophisticated industrial trade policy. Development of cost-effective advanced processing technology should be a high priority for China.

China should also act responsibly in order to encourage higher price levels for primary products. For example, China stands to benefit from stronger prices for tungsten, antimony and rare earth products in coming years. For some metals, further processing will advance more rapidly. For example, iron and steel exports are expected to shift from iron-semi towards wires, bars and other products.

Table 15. China: exports of nonferrous metals and minerals (thousand tonnes)

Items	1983	1984	1985	1986	1987	1988
Tin & alloys	3.6	2.6	7.3	7.4	15.9	10.7
Antimony regulus	12.2	17.3	16.0	21.6	29.6	29.3
Zinc & alloys	2.1	1.5	2.4	56.8	95.3	13.8
Copper finished	9.5	7.7	4.2	9.2	22.3	44.3
Aluminum finished	10.6	6.0	5.7	6.1	20.2	28.9
Tungsten concentrate	22.2	18.9	21.3	23.6	23.1	27.3

Sources: Foreign trade statistics, China's foreign trade yearbook, China's hydro-energy publisher, 1985; *China Statistic Yearbooks*, 1985-89, Statistic Bureau China.

[17] One tonne-grade unit equals 10 kg of WO_3 equivalent.

5. Problems in China's Metal Mining Sector

There are many constraints and obstacles to development of China's metal mining industry: lack of accurate and complete information on the mining sector itself; inadequate geoscience data and resource exploration; inadequate mining regulations; lack of an overall development strategy and lack of efficient management; backwardness of equipment and technology; challenges to the public sovereignty over natural resources – these are among the many reasons this sector remains relatively underdeveloped while the economy in general has advanced more rapidly. Difficulties caused by neglecting internal specifics of the mining industry, such as the hard living conditions in isolated small mining communities, have brought additional problems.

The metal mining sector is one of the weakest links in China's economy. The painful shortage of metals and of raw materials in general has led a number of thoughtful economists to recognize that too much precious time, most of the decade of the 1980s, has been lost. The policy that led to this imbalance had originally been designed just for narrow coastal areas. It was characterized as "starting from the very end", i.e. beginning with downstream or finished product fabrication. Unfortunately, this localized policy was transformed to become an overall strategy for the whole country. It spread everywhere, and lasted for most of the past decade.

Capacity and Technology

China was the third-largest mineral producer in absolute terms, following the U.S.S.R. and the U.S. in the mid-1980s. World annual mineral production (excluding oil and gas) was about 180 billion tonnes; this works out to a per-capita figure of 3.8 tonnes. China's production was 14.8 billion tonnes; the per-capita level was 1.4 tonnes, only 36.8 percent of the world level. This low per-capita share of mineral production meant a serious and continuing domestic shortfall in energy and raw materials. By the end of the decade, it led to a reassessment of the rigid 1980s "starting from the very end" policy, which had given lower priority for investment and expansion to mining than to the more advanced industrial and manufacturing sector.

In China's major mines, annual per-miner extraction averages about 5 to 10 tonnes of ore, compared with 50 to 100 tonnes or more in other countries. Obsolete mining and metal processing equipment is in use everywhere in China. This is largely due to an extremely low (5 percent) annual amortization rate and low availability of investment funds for this sector. Mining techniques and technology are backward, as well. A few of the larger iron and nonferrous mines were able to obtain some updated mining equipment in the 1980s. On average, however, the technical level has been below the world standard for two or three decades. Most mines are provided with equipment of low capacity, low ability and low efficiency. Equipment and parts are rarely compatible, even in any one mine.

Most large- and middle-scale mines, with the notable exception of the Antaibao open pit of the jointly owned Sino-U.S. Pinso coal mine, are still equipped with machines from the 1960s and 1970s at best. There is an urgent need for research, development and manufacturing capability to modernize and mechanize mining technology.

Annual increases in new iron ore mining capacity on average can replace only 20 percent of the losses due to exhaustion of existing capacity. Most nonferrous and gold mines are aging too, their output diminishing as their reserves are exhausted. Ninety-six existing nonferrous mines will close by the year 2000. A number of the major gold mines have proven reserves for only a couple of years. The same is true for half of the state-owned gold mines. Less than half of the major nonferrous mines have reserves which will last more than ten years. According to a newly completed survey of five tungsten and five copper mines, the grade of extracted tungsten ore has decreased by 28 percent, and that of copper by 6 percent, over the last 30 years.

One of the main reasons for declining grades and resources is the significant decline in funding allocated by the state agencies to the exploration and mining sectors in the 1980s. The decision-making agencies were not willing to take a long-term view. They postponed or avoided mineral investment because of the long gestation period required for payback and the low rate of return on the large capital investment. Take the example of iron ore mines: investment in this sector in the 1960-80 period was only 20 to 25 percent of that in the iron and steel industry, and it decreased to 11 percent in 1981-85.

All mines faced the same investment policy. It is hard to imagine that recovery from the resulting severe and lasting decline in reserves, mining capacity and other facilities can be accomplished by new investment in a short period of time.

Management and Planning

China's economic planning and management system determines the specifics and the nature of, and changes in, the mining sector, its strengths and especially its weaknesses. Despite state-ownership and the resulting interrelationships between mining organizations and state or local administrations, China's economic legislation and regulations have been designed mainly to promote the manufacturing sector. Policies which until the late 1980s directed investment, incentives, and allocations of materials and equipment towards downstream fabrication have slowed the development of the metal mining sector.

Most of the state-owned mines operate under the administrative control of a distant headquarters. Even the cut-off grades of ore are frequently set by administrative fiat. The waste of ore reserves has been significant, due to the lack of financing for mine development, the lack of effective supervisory control, and inadequate mining geological services.

State administration of mining sector is partitioned on the basis of its products, as shown earlier in Table 4. The Ministry of Metallurgical Industry is responsible for iron and steel production. Major nonferrous metals production is controlled by the National Nonferrous Metal Corporation, a state economic agency. The output of individual major metal mines is allocated to different smelters or processing plants by one of two state departments, according to whether they are producing ferrous or nonferrous metals, but rarely with regard to the presence of coproduct and byproduct metals. As a result, much of the valuable metallic content is lost.

To eliminate inefficiencies in this sector, all of these problems and more must be addressed. For example, the immense iron ore resources in An-shan-Benshi counties of Liaoning province and Tangshan district of Hebei province are under-developed, largely because the operating organization, the local iron and steel works, has little interest in increasing mining capacity beyond its own processing capacity, or in selling the ore to others at the mandated low prices which would result in low profits. As noted above, the administrators for one commodity usually ignore other mineral products or coexisting minor elements found in the deposits under their control, leading to waste of by-products and co-products. Separate confidential regulations for geological information frequently result in costly and inefficient repetition of geological observations in the same districts and on the same level. Increasingly, solutions to such problems are being found by local municipalities as they gain more authority over mining regulation, since they deal more sympathetically with mining organizations than do the central agencies.

Central planning projections for the iron and steel industry in the 1950s have proven unrealistic, for a number of reasons. The principal raw materials, coal and iron ore, are found mainly in remote regions without adequate transportation systems. The investment required to development these resources was not available, as the planning emphasis was directed more towards energy and manufacturing. For example, when the energy industry became the first priority in the national economic development plan of 1980-85. Other industrial developments, even those based on raw materials, did not rank high in the main selection criteria with respect to financial resources and market considerations. In the 1980s, new developments in the aluminum industry were usually located near power sources, because of their high electricity requirements, no matter how far they were from the mineral resources. Although it improved their access to electricity supplies, this option at the same time caused difficulties in transporting high-bulk, low-value raw materials to processing plants, given the size of the country and the level of development of the transportation infrastructure.

Since the mines producing various minerals are vertically integrated within commodity-specific specialized departments, or controlled by local authorities, there is a weakness in the horizontal linkage between similar operations in the mining sector. This impedes communication and technology transfer. Externally as well, each mining administration makes its own technology exchange linkages directly with other countries and does not take adequate advantage of available technology within other Chinese agencies.

The comparatively high national income of the early 1980s in China could have provided more investment funds for the mining sector. Instead, in pursuit of the "starting from the very end" policy, billions of Yuan in "agricultural loans" were put into a huge number of local or rural manufacturing operations that had no stable raw material sources. Nearly half of these enterprises closed during the economic setbacks the late 1980s. Furthermore, everywhere there were long lists of conspicuous nonproductive construction. Adding to the problems was the uncontrolled expenditure of several billion US dollars on importing durable goods, including a very large number of small vehicles for staffs of local authorities. And finally, the mining-specific policy itself was not much help, because it did not call for new investment or expansion of production.

Low Fixed Prices for Metals

The fixed price levels for mineral products was below real market values for three decades. Mineral prices in China were the lowest in the world, with some metal ore concentrates selling at prices that were below world market prices by 50 to 60 percent.[18]

Iron ore: the fixed price of per tonne of concentrate with 64 percent metal content was Yuan 73.5 in March 1990. In early July 1990, this mandatory price was adjusted to Yuan 88.6, which was still only 48.2 percent of import cost.[19]

Tungsten: in the late 1980s, the free-market export price per tonne of 65-percent wolfram trioxide concentrate was about US$4,000 (Yuan 19,000, based on the mandatory exchange rate of US$1= Yuan 4.75). The mandatory price of this commodity at the time was as low as Yuan 13,520. Such pricing reflected neither the cost of production nor the demand-supply situation.

Copper: unbelievably, the mandatory copper price was frozen at Yuan 5,500 per tonne for more than twenty years, from the early 1960s to 1988. This forced mining companies to focus on high-grade ores for the production of concentrates, avoiding low-grade resources and difficult mining conditions. In 1986, the world market price fell unexpectedly close to this fixed price, in the period of low demand, high investment and overcapacity, and then recovered to much higher levels. Although significant adjustments have been made to the fixed price in the last two years (to Yuan 6,800 in 1989 and then climbing abruptly to Yuan 18,500 per tonne in May 1990), it is still well below the market price of Yuan 22,000. Persistence of the low fixed price made it uneconomic for most Chinese copper mines to sell their product to the state supply agency, especially when extraction was going on at deeper levels.

Most of the state mining enterprises, hurt for years by low price levels for mineral products, have in effect been obliged to subsidize their clients, and at the same time to pay various taxes and mining-specific surtaxes. Any profits were turned over to the central agencies. No funds were available for rehabilitation and reinvestment. About 60 percent of the existing state-owned nonferrous metal mines are old. Due to their failure to reinvest, their capacity is expected to decline by 40 percent by the year 2000, although other new operations are under construction.[22]

The situation of smelters and especially of metal processing plants is much better than that of mining operations, due to the low prices they pay for raw materials and the more flexible price levels for ingots and finished products. This accounts for the anomalous situation of nonferrous metal-in-concentrate capacity at 1.8 million tonnes, smelter capacity about 2 million tonnes, and processing ca-

[18] Liu Chang: Changing nonferrous market, *Nonferrous Metal Review*, April 19, 1990.

[19] *Metallurgical News*, March 22 and July 24, 1990.

[20] *Industrial Bulletin of China*, 1989, no. 12.

pacity "mysteriously" at 2.5 million tonnes and continuing to expand beyond either the centrally planned or the regular market expectations. In aluminum, for example, there are twenty foil plants, mostly state-owned, operating or under construction; total capacity is already beyond the domestic consumption level. Nevertheless, more than thirty other local plants are being built. At the same time, the foreign trade agency imports this foil in quantities large enough to damage the existing capacity. The total capacity of the fourteen existing beverage-can lines is 2.36 billion pieces per year, but the current annual production of this capacity is limited by the state plan to just 600 million pieces. This does not impede the trade agency from importing an additional 800 million pieces.[21]

Given the low fixed prices for primary products and the capital allocation policies, metal mines have been unable to find investment funds to implement technological innovations, except for the rare few that were able to obtain new state support. In fact, many metal mines even had difficulty in meeting employees' salaries, although sales volumes were good and the costs of production were below the cost of importing metal concentrates. One serious consequence has been the industry's inability to attract and keep qualified workers. In fact, very few of the younger generation are willing to enter the mining schools. Consequently, to reflect the reality, the Centre-South College of Mining and Metallurgy and the Tangshan College of Mining and Metallurgy, despite their respected historical traditions, have refocused their programs and been renamed the Industrial University and the Engineering and Technological University, respectively.

Mandatory government purchasing monopolies, combined with low official prices and higher free-market prices for gold, tin, antimony and tungsten, encouraged local corruption by creating an irresistible opportunity for intermediate traders to smuggle much of the valuable output from small mines to markets outside the state allocation system.

Attempts by central authorities to control illegal mineral trading by small mines have also been unsuccessful. Competition for foreign markets has led to unorganized transactions involving Chinese mining products and to price cutting and lower prices for some exported goods. This competition has resulted in a lower overall return, despite the increased volume of export goods.

Although adjustment of metal prices to reflect world market prices might create a surge in development of the Chinese metal mining sector, the sector has deteriorated to the point where reaching proposed targets for enlarging capacity within a limited time will require special financial support. For iron ore mining, for example, the proposed increase in steel production from 60 million tonnes in 1989 to 100 million tonnes by the year 2000 will require an additional 86 million tonnes per year of pig iron, and accordingly 244 million tonnes of crude ore. This in turn will require an investment of Yuan 10 to 13 billion over the next decade. Annual investment, therefore, should be about Yuan 1.3 billion. In 1989, however, investment in the sector was only about Yuan 900 million.

Exploration and Expansion of Reserves

In order to expand reserves and production, China needs more mineral discoveries. Unfortunately, hampered by a limited budget and a huge workforce, the state geological agencies do not have the organization or operating funds to provide effective geological services. There is total reliance on the state for exploration and geoscience funding, and the administrative rather than economic style of management of this service makes it very unproductive.

The state geological survey and exploration budget for 1989, excluding that for oil and natural gas exploration, was Yuan 3.31 billion or 92 percent of the total geological agency's budget. Between 1985 and 1989, the geological budget increased by only 22 percent. Over the same period, however, the consumer price index rose by 70 percent, resulting in a 56 percent increase in salary levels for geological personnel, and a concomitant decrease in available operating funds for materials, equipment, travel, etc. The annual average wage for each worker was about Yuan 4000 in 1989.

At the same time, this shrinking budget is not being used effectively. The sector is severely overstaffed. In 1989, the geological sector was made up of 766,000 members (employees and other associated individuals) including 104,000 pensioners and 639,000 workers. Due to overstaffing, the limited funds could not be used effectively or pro-

[21] Fen Shaojen: Concerning the current situation of nonferrous metal processing and strategies for getting over their difficulties, *China's Nonferrous Metal Review*, May 31, 1990.

ductively, The current multi-levelled administrative staff of the agency is enormous as well.

Underemployment of this excessively large workforce can be seen, for example, in the fact that a drilling unit usually consisted of as many as 20 to 40 workers, compared with only 6 to 10 workers in other countries. Annual production per driller was one tenth of that in western countries and one sixth of that in the U.S.S.R. Preliminary exploratory drilling work in 1989 was 3,530 thousand metres, a drop of 56 percent from the 1985, a clear reflection of the drop in available operating funds as wage costs grew. The decline in newly proven reserves in 1989, fortunately, was not as drastic as the decline in drilling work, due to "living on its own fat".[22] But this scenario cannot last much longer. Unless significant changes occur, geoscience and exploration efficiency can be expected to decline rapidly.

In the author's view, the size of the workforce in the geological survey must be reduced as quickly as possible. As Wang Xinkai of the Ministry of Geology has stated, only about half of the current 766 thousand workers are necessary; the rest might be transferred to other businesses or retired. A key question is: Where can the surplus workers go?

An interesting example of the sort of transformation that can be accomplished within the Chinese system has been created by Geological Team no. 309, a subordinate unit of China's National Nuclear Industry Corporation.[23] This unit, with 1,100 workers, started shifting away from its geological role to diversified businesses in 1985. In the last five years, the following enterprises and occupations have been created by this collective: mechanical works, vehicle-repair garage, printing shop, beverage factory, soy sauce mill, delivery team, auto-training school, and hydrogeological survey centre. It has been very successful in this transition process. Its mechanical works is the sole producer of replacement piston rings for imported Japanese vehicles in China. In the 1989 Hubei provincial competition for repairing vehicles, contenders from this collective won a gold medal. In 1990 it reported financial results including revenue of Yuan 10 million and net profit of Yuan 1.3 million. All its employees have willingly accepted their new jobs in this modified collective, in order to keep working.

Eight of the eleven geological units in Jiansu province, the best reformed area, have evolved into similar hybrid organizations since 1984-85. Most were still mostly dependent on state finance support in 1988, but two or three of the units already have significant stable business partners and incomes and are able to operate commercially. In this province and elsewhere, it appears that the old system of regulation and control is still the dominating factor.

The question of keeping the best components of personnel active in geological research and exploration is more complicated. There has been considerable loss of talented young and middle-aged technical staff to more profitable industries for better wages, and there are few new additions to the ranks. Enrolment in geological educational institutions has dropped drastically. Even in the populous province of Jiansu, there were no applications to enter any higher education department of geology in 1989-90. Not only is reform of geological units urgent, but improving the work environment is even more important.

One essential step seems to be ensuring a viable future for the existing geological and mineral exploration units. This will include improving the quality of the workers and staff and setting up an efficient decision-making process and structure. Labour-intensive activities of these organizations should evolve towards technology-intensive ones. This in turn will require increased capital and operating funds. One possible source for funding is a user-fee system, to generate revenues in return for information and services, such as geological data and identification of mineral deposits.

Since the Mineral Resource Law was enacted in 1986, all plans for geological activities must be registered at a provincial resource agency, in order to get a loan from an investment bank to conduct the work. This measure has eliminated one earlier problem, the confrontation between competing geological teams from different departments for exploration rights in the same areas. But there are still some unsolved problems. For example, because registration fees are low and there are no set expenditure requirements, any geological team can occupy as many working areas as possible, and prevent other teams from occupying them, even if their work plan, abilities and financial resources are too limited to take advantage of their holdings. Appropriate steps must be taken to resolve this problem.

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[22] Wang Xikai: Some opinions on rationalizing the geological and prospecting industry to deepen the reform, *Geological Economy of China*, No. 3, 1990, pp. 1-9.

[23] Lin Junfu: How Geological Team No. 309 entirely changed its profile, *Geological Economy of China*, No. 10, 1990, pp. 36-40.

6. Small-Scale Mining Activity

The performance of small mining operations is extremely varied, and any attempt to generalize would be misleading. The following section sets out a brief description of the range of performances and some of the problems encountered. Small-scale mining in rural areas began long ago, but a period of rapid growth began in the early 1980s. At that time, more than 100 million Chinese peasants were living at or near the poverty line. Economists, realizing the necessity for rapid growth of rural income, began to stress the diversification of the rural economy.

Since the late 1980s, the rural population have been encouraged to improve their incomes either in agriculture or in other jobs. The new policy allows unemployed or underemployed peasants to seize any possible economic opportunities by utilizing both surface and underground resources to make money. As a result, both the public and private sectors have managed to get into mineral extraction. By 1984-86, one fifth of the income of the rural population was reported to arise from mining. There are many different types of small mining operations and many different types of ownership, including local, state, collective and private organizations.

Contributions

With little investment, small mines were quickly able to generate considerable quantities of mineral products for domestic and export markets. By 1988, they contributed about 21 percent of the raw material production of the whole country. There were 22 million miners working in about 7,800 collectives and 120,000 private operations. They produced 16 percent of the iron ore, 30 percent of the gold, 16 percent of the nonferrous metals, and 70 percent of the nonmetal minerals in China. In Henan Province alone, small mining operations employed more than 300,000 workers. In some less-developed areas, 30 to 50 percent of the workers were miners. Small mines have become a major anti-poverty measure.

A typical example of a locally organized mining industry is the iron ore mining and processing industry in the Tangshan district of Hebei province. Twenty thousand people are employed in 97 plants with annual capacity of 10 million tonnes of crude ore and production of 3 million tonnes of concentrate. Their products are used by 38 iron and steel works in 11 provinces. Total investment was Yuan 300 million, only one third of the norm for state-owned mines.

Difficulties and Confrontations

Accustomed to looking only at the short term, most small-scale mining organizations spent all their income, and had no savings to reinvest in their operations. There is a universal lack of infrastructure, such as roads and energy supplies, and of capital facilities for hoisting, water pumping, ventilating and lighting. As a result, there are severe safety problems as well as production problems. A number of mines are extracting only the surface reserves and have no long-term intention of recovering the underground ore. Forty-three percent of the small iron ore processing plants of the Tangshan district operate below capacity because they do not have adequate supplies of crude ore; one third of them have no long-term raw material supply arrangement with the mines.[34] Their own reserves cannot last long.

Mining legislation that is inadequate to cope with small mining, and the lack of an overall mining policy that is also an integral part of macro-economic management, are additional sources of problems. For example, there have been many reports of confrontation between small mines and state-owned mines, usually because of unsatisfactory disposition of mining rights. The absence of a professionally prepared mining plan and of current

[34] Xe Jeheng: Helping small mines, *Metallurgical News*, March 27, 1990.

technology and facilities in the small mines is a result of inadequate regulation as well as inadequate financial resources.

China's National Mineral Resource Law, accompanied by a statement of The Public Sovereignty over Mineral Resources, was enacted on 19 March 1986, about five to eight years after the start of the boom of small mining. Introducing regulation to this disordered sector was an enormous task. Confrontations between state-owned (central), collective (local) and private miners continued to arise. According to China's *Economics News* (March 5, 1990), 70 percent of state-owned mines had difficulty with their rural venturers. Uncontrolled small-scale mining was interfering with existing large tungsten, tin and antimony mining operations. Fourteen state-owned operations in the provinces of Hunan and Jianxi lost 470 working days' production due to shut-downs resulting from such confrontations. Ten of 49 newly planned state nonferrous metal mining projects were found to be already occupied by rural small mining venturers. The number of mining "hot spots" increased from 100 in 1987 to 146 in 1989. Copper, bauxite, lead and zinc, and even China's more important resources such as tungsten, antimony, tin, and ion-absorbing rare earths are all affected. Some of the cases of confrontation between large and small mines are described below.[25]

Shikuanshan, the World's Largest Antimony Mine

Shikuanshan in Hunan province, is the largest antimony mine in the world. It has been troubled by local venturers who invaded its territory to share in the wealth. More than 130 private or collective units and thousands of miners moved into the area, interfering with the existing state mining enterprise. They were so overwhelming in numbers that local authorities were unable to interfere seriously in their activities. These local venturers had no geological information, no mining designs, work plans, nor technical instructions. They simply mined out any ores that were in sight, aiming for a fast return at minimum cost. Accidents were frequent. Unless this situation can be controlled in a short time, the world-famous antimony deposit with its 7-million-tonne reserve will be exhausted in a few years,[26] and much of its potential will go untouched and wasted because of the haphazard high-grading that has occurred.

Gold Rush in Qinhai Province

On May 25, 1989, 4,000 vehicles and 8,000 homes of gold miners were caught in a avalanche in the Kokosili mining district of Qinhai province. Forty-two persons died and assets valued at Yuan 1.42 million were lost. The accident was caused by the failure of municipal authorities to regulate the issuing of gold mining permits. This led to disordered and unsafe mining activities. Despite State Council Order number 75 of 1987, requiring that gold mining permits be issued exclusively to state and collective units, and not to individual private miners, more than 28,000 private permits were issued illegally, and actual venturers numbered about 30,000, twice the acceptable number. It was reported later that the over-issuing of gold mining permits had been the work of corrupt municipal officials.[27]

Bauxite Deposits

Three years after the Mineral Resources Law was enacted, crude and illegal mining methods were still in use in two mines of the Guizhou Aluminum Corporation. A huge number of local peasants invaded the corporation's operating areas, extracting bauxite, even stealing extracted ores. They dug their own holes in the mines' large pits, extracted high-grade ores and filled the holes with waste, which made further regular extraction impossible.

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[25] This was recognized as so serious that, in March 1990, the Chinese authorities arranged a telephone conference of mine managers to discuss the problem.

[26] *People's Daily*, February 3, 1990, p. 6.

[27] *People's Daily*, March 12, 1990, p. 6.

County collectives and private ventures built more than 80 primitive furnaces inside the operating and projected areas assigned to the corporation, and set up production of fireproof materials from bauxite. The recovery ratio was only about 30 percent. Not only was the Guizhou Aluminum Corporation unable to deal with the rural venturers, but it was forced to purchase raw materials from them, instead of using its own mining operations.

Much the same thing happened in the bauxite deposits of Henan province. From 1981 to 1985, five million tonnes of bauxite were used to produce fireproof bricks by local venturers.[28]

Lanping Lead-Zinc Deposit

Unorganized lead-zinc mining has been stopped in Lanping. The unique domestic Lanping lead-zinc deposit in Yunnan province had suffered from anarchic mob mining for several years following 1985, as more than 10,000 private venturers extracted ores. It has been estimated that entrepreneurs made as much as Yuan 4 million through illegal trade in the ore and concentrates. The local authorities began to renew mining permits and regulate the commercial extraction of ore in the winter of 1989, and the situation is expected to improve.[29]

Yuinlun Tin Mine

A new tin mine, Yuinlun, with a daily ore-processing capacity of 200 tonnes was built in 1985. Total investment was Yuan 12 million. In 1986, local venturers entered the operating area and sank 108 holes to reach the mother lode directly. The life of the new mine was drastically shortened almost from the day of its opening. About 70 percent of the reserves have been lost or wasted.[30]

Shiaoqinlin Goldfield

A variety of interests collided in the Shiaoqinlin goldfield in Henan province. There were 30,000 miners from a variety of state departments and local state, collective and private units, working hundreds of gold-quartz veins within an area covering hundreds of square kilometres. No one but the provincial authorities had the power to strike a committee to control the miners.[31]

Dabaoshan Iron Ore Operation

One of the successful examples of established order was in the Dabaoshan iron ore deposit, Guandung province. After three years of confrontation, a provincial commission, in conjunction with two neighbouring counties, outlined the boundary of the operating area of the state-owned enterprise and eliminated private mining venturers within it.[32]

Piautang Tungsten Operation[33]

After some problems, the state-owned Piautang tungsten operation in Jianxi province was able to define its operating boundaries. However, the mine was not permitted to extend its activity beyond this limited delineation, regardless of the extensions of the deposit. On the other hand, rural venturers, occupying all the surrounding territory, began extending their tunnels and underground excavations directly into the orebodies being worked by the Piautang operation.

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[28] *People's Daily*, February 3, 1990, p. 6.

[29] *People's Daily*, February 3, 1990, p. 6.

[30] *People's Daily*, February 3, 1990, p. 6.

[31] *People's Daily*, February 3, 1990, p. 6.

[32] *People's Daily*, February 3, 1990, p. 6.

[33] Zhu Shenlin: "A current case of battle for public resources", *China's Nonferrous Metal News*, July 22, 1990.

Conclusion Concerning Small Mining Activities

The current growth in small-scale mining is a result of a combination of current and long-term factors. The State Bureau of Mining Regulation was established in the Ministry of Geology and Mineral Resources in the early 1980s to look into natural resources as state-owned property. At the same time, outside this newly created department and not coordinated by it or with its program, an ill-conceived policy of "Liberating small mines, letting streams flow faster" was announced by a more senior government agency. This conflicted with the general mining regulations and policy in effect at the time, and came into effect before the new Mineral Resource Law was enacted in 1986. As a result, existing large-scale mines encountered unexpected difficulties during the 1980s.

The problems of a long-term nature were twofold. First, the industrial policy and inadequate financial resources led to shortages in the domestic supply of minerals, while demand for these materials increased in the urban areas. Second, as rural policy became more flexible in the late 1970s, agriculture became more productive, and released an immense labour force that urgently needed to find new employment. The opportunity to dig their own income from beneath their own feet was too good to resist. It was simplest for the decision-makers to avoid thinking too deeply about this matter, even though by hindsight it is obvious that better organization of small mining might have created more benefits with less cost.

Whether or not one would like to criticize the behaviour of the present small mining ventures, the reality is that government and industry are unable to provide suitable jobs for the enormous unemployed or underemployed rural population. Certainly, mining legislation and regulations are important to the industry, but they cannot solve the fundamental problem of widespread unemployment. The eventual solution will have to include redirecting a good number of rural venturers to other fields of occupation.

Obviously, the problem of rural venturers is not one that can be solved by the mining industry alone, nor is it one of restructuring the mining industry. Rather, it is national in scope and is complicated by the many levels of authority involved. Small mines represent local interests directly, but the large mines belong to the central authority. Although economic reform outside the metal mining sector cannot be discussed in detail in this report, the investigator feels that reform of the metal mining sector can occur only in the context of general reform. At the same time, reform of the mining sector may bring some constructive influence to this general reform.

7. Observations on Future Directions

A policy of dependency on raw material imports, like that of Japan and some other developed countries, does not seem appropriate for China. China has less ability to pay for imports, enormous reserves of natural resources, and an enormous labour force, idled in rural areas, that has to be employed. The mining sector is unavoidably fundamental to China's major industrial strategy. In the coming decades, domestic mines will remain the main supplier of China's raw materials. China has no choice but to elevate the status of the metal mining industry to make it more productive, and to reduce imports of metallic minerals and metals.

Significant managerial and financial subsidies will be needed to sustain and expand this essential sector. There are many economic, technical, legislative, and administrative issues to be faced. Responsibility for this sector lies with many professional and administrative institutions and levels of government. The core of any measures for reform of China's economy lies in the restructuring of the mining sector.

At present, the existing system and the attitude of those responsible for general economic policy are not favourable to the growth or even the continued existence of the metal mining sector. To overcome the present problems of the industry and increase its productivity in a relatively short period of time, even with other aspects of economic reform on stream, a series of urgent public assistance measures or preferential policies will be needed. The author advocates reform of the mining sector as an essential step towards accomplishing overall economic reform, and as a fundamental part of economic strategy.

A long-term view of metal production and rational utilization of mineral resources is needed, rather than the present notion of short-term capture of revenue. This is not simply a mining issue, as discussed earlier. Small-scale mining has penetrated every possible corner of rural areas, and has even spread to urban districts. Solving all the connected problems will require a wide-ranging social and economic reform strategy covering both urban and rural areas. For instance, mineral resource development strategy could be paired with the family-planning policy as the long-term national fundamental strategies of first priority. At the same time, short-term intensive development of the mining industry is also important.

What follows is a brief outline of some of the initiatives that will be needed in the course of restructuring China's metal mining industry at this stage of social development and the early phases of restructure. A more detailed blueprint must be evolved in the ongoing course of reform.

Reform of the Geological Service

The core of the reform of geological units should be transformation of these administrative bodies into independent enterprises. By the 1980s, geological units had become merely administrative institutions which were wholly dependent on state budgets and which existed to monitor operations. The first step of this reform might be to maintain a number of state monitoring projects as before, but permit the addition of business contracts in the open market, so that these two mechanisms can function simultaneously. Once economic contracts generate significant financial resources for geological units, they will perform as quasi-enterprises in society. Once geological units are working mainly on economic contracts, they may evolve further into fully independent enterprises.

A shortage of proven reserves is a growing problem for most of China's metal mines. It is impossible for the central agencies to send out enough specialized geological teams to solve this problem. Mining enterprises should be provided with financial and other forms of support from central agencies, and permitted to expand their own on-site or nearby reserves. Once mineral prices are adjusted upward, mining enterprises will able to raise their own funds for exploration. In the meantime, a special prospecting or exploration subsidy

will be necessary. Mining enterprises in good financial condition must be prepared to pay for exploration services and for access to reserves discovered by others. Small mines must manage their revenues so they can reinvest a portion in exploration, as a means of extending their mining activity.

Evolution of Metal Mines Into Mature Enterprises

Mining operations should be neither the captive appendages of processing and smelting plants, nor divisions of any ministerial and provincial administration. It is necessary to make mining operations into independent and efficient enterprises, able to respond to their own economic stimuli and obligations. This must be done without delay. Any success realized in the metal mining sector in China in recent years has been the result of permitting the mines to function as mature entities.

The author envisions a successful mining enterprise as one which will be capable of ensuring that every possible valuable component or element is extracted from the ore. It must operate on the basis of newly adjusted and recognized reasonable prices. Deposits in remote areas should be developed by joint ventures with local groups, so that the municipalities and local population will take an interest in their development. Most mines should perform as local but broadly market-oriented entities, in accordance with general mining codes, and serving markets wider than the local needs. This transformation will require deep-rooted economic and administrative reform.

Implementation of the Mineral Resource Law

The main aim of the 1986 Mineral Resource Law is to protect state-owned subsurface resources from illegal and inefficient extraction. Undoubtedly, this law and the associated mining policy will be of assistance in economic reform at national level. It is also important to strengthen the control and guidance of the mineral resource administration at prefectural and county levels.

China's economy has long performed below expectation. There is strong pressure to enforce the Mineral Resource Law, from all groups who seek an immediate rise in their living standards. China's small mines and the rural economy generally are extremely complicated areas, where application of this law and of economic regulation must be made cautiously. Any improper action might cause unexpected and large-scale social unrest. Therefore, a connection must be made between the mining code and regulations with rural anti-poverty policies. This certainly will not be a simple matter.

Prices, Taxes, and Resource Evaluation

The commodity price system is artificial and out of touch with reality. The mandatory prices set for most mineral products are too low, both from the standpoint of production cost (and taxes) and in view of market prices. No restructuring can be successful without simultaneous reform of the price system and the taxation system for mineral resources.

Modification of the pricing structure may require some controls, as interim measures before switching to market prices, given the realities of the present system. Interim procedures would include raising the mandated prices for primary goods, including metal mineral products. The price of any mineral product might be determined on the basis of the producer's cost of utilizing a marginal mineral resource. In China today, a reasonable interim price system must aim at long-term survival of an economic mining industry. This interim price must cover the cost of exploration, development, mining, and processing, as well as taxes and royalties. It must not be significantly lower than the cost of imports. These considerations have been overlooked in past price-setting and must now be taken into account.

Pricing policies as well as royalties and tax systems must take into account the variations in deposit types. Mining and income taxes should be reduced below the levels for the manufacturing sector. It may even be necessary to offer financial assistance to some individual mining entities in the short term.

State tax laws for the oil and coal industries have already been enacted. For other kinds of mineral resources, Liaoning, Beijing, Henan, Fujien, Shanxi and Ninxia municipalities are making use of local regulations to collect fees for exploration, mining

and management from each mining unit. These local regulations are generally very simplistic in design; usually, a specific fixed fee is charged according to the kind of mineral product. In general, these local levies are volume-based or fixed taxes rather than a project-based tax. This tends to discourage marginal projects, and to encourage inefficient extraction of high-grade ore. A better approach might be a progressive income tax, or an excess-profits tax on easy-to-extract or high-grade or low-cost resources. This would add flexibility to the system, and encourage marginal operations while at the same time capturing some of the profits from the lower-cost operations.

Compensation fees, or royalties, should be payable by the mines to the state as owner of the resources, and used to establish funds for geological studies, exploration, and development, according to the principle that "what comes from the mining sector goes back to the mining sector". Royalties should be volume-based.

In summary, government revenues received from mineral resource exploitation may be divided into the following three categories:

- payments for geological data gathering and exploration;
- volume-based royalties for extracting non-renewable mineral resources, to be included as a production cost;
- profit-based or progressive taxes on revenues, to capture profits from high-grade or low-cost deposits.

Investment Incentives

Mining is capital-intensive, with high up-front capital costs. However, China's economists have a distorted view of the "extremely high unit investment" required for mine development. This misconception has resulted from past failures in mine construction, resulting for example from making decisions without adequate deposit delineation and feasibility studies. These failures gave an upward bias to capital requirements for this sector as a whole.

Since the independent financial viability of the Chinese mining sector cannot be assured in a few years, the investment capacity of mining entities will remain weak. A targeted state investment policy is therefore recommended for the mining sector. This could take the form of public subsidies such as grants and low-interest loans as well as direct investment.

Once the economic and social environment in China has improved, independent foreign investment and joint ventures will be appropriate. Successful cooperation among mining companies, local authorities and economic agencies will be essential, to facilitate economic project construction and operations.

Interim measures, such as preferential loans, upgrading in technology and management, quality control and safety training, should be aimed especially at private and collective small-scale mines with good potential in terms of their mineral reserves and markets. These are the mines with the best chance for long-term survival in free market competition.

Updating Technology

Although it will be necessary to import equipment in the short term, over the long term China's machinery and equipment industry should be able to meet some or most domestic requirements. Some mining equipment has already been developed, but it has yet to go into production. China should target development of a complete mining equipment industry, to produce up-to-date equipment for ore extraction, transportation and processing. This will require gathering teams of experts from different sectors in China, as well as foreign collaborators, to produce equipment and parts that are compatible. Overall coordination will be needed; this in turn will depend on restructuring of the manufacturing sector, which is still fragmented and controlled by several administrative agencies. In addition, training will be needed to improve efficiency, quality control, management and technical competence.

Upgrading Mining and Processing Recovery Rates

Higher recoveries of metals and less waste are goals of the Mineral Resource Law under its provisions related to Charge for Exhausting Mineral Re-

sources. Improved extractive recoveries and lower dilution must be among the main goals for mine managers.

In nonferrous mines with high pyrite concentrations, sulphur emissions to air and water must be reduced. Higher recoveries of sulphur will serve two aims: the shortage of sulphur and sulphuric acid will be eased, and the environment will be improved. Valuable co-product and by-product minerals and elements must be recovered as well. Incentives to investors are suggested, to encourage mining and processing activities that can transform sources of pollution into valuable products. At the same time, penalties will be imposed for pollution.

High staff turnover and lack of skills among the technical personnel have slowed development in the mining sector. Higher salaries are needed, to support an improved living standard for employees. Wage levels should take into account differences in job types, risks, and quality of working environment. For example, field workers' salaries could be higher than those of urban employees; underground workers' incomes could be higher than those of surface workers; special subsidies for high-risk and hardship posting could be offered; a bonus system for miners could be established. To increase the flow of young people into the industry, incentive grants could be offered to students at geological and mining schools, similar to those already in place for teachers' training schools. Most training centres are needed in major mining centres, to improve worker qualifications on an ongoing basis.

To improve living conditions and reduce unemployment in mining regions, economic diversification could create employment opportunities for the younger generations of workers' families. A good part of the environment tax collected should be kept on-site in mining areas, to improve local living conditions.

8. Implications for Canadian Trade in Metallic Minerals

China's success in meeting its domestic requirements for metals will depend on development of its domestic mining sector, affordable imports of metallic mineral products where shortfalls occur, and effective and economical utilization of available metals and other primary materials.

Canada produces minerals far in excess of domestic capacity, and depends on export markets for its mineral output. Increasing demand in China for many of these mineral products is coming at a time when mineral consumption growth is relatively static in Canada's traditional trading partners within the OECD. The author suggests that Canada can take advantage of these differences in the phasing of national economic development in its trading partners. A metallic mineral trade relationship between Canada and China could be important for both, not just as a casual opportunity, but perhaps as an historical necessity.

Bilateral or multilateral balances are needed for long-lasting trade partnerships. China's need for imports of metals and raw materials will continue to be considerable for some time to come. In its trade with China in 1988, for example, Canada had a surplus of US$1.84 billion.[34] Before this trade relationship can be developed further, it will be necessary to reduce the imbalance.

China will continue to develop its economy, including its metal mining industry, as its social situation improves, but its development will not parallel that of Japan in the three postwar decades. It will be impossible for China to raise its per-capita production of metals to Western levels in the foreseeable future. Nor does it need to, as long as affordable imports are available. The rational conclusion involves joint efforts from both sides of the Pacific Ocean.

When appropriate, Canadians should encourage Chinese joint ventures in Canada, to help China secure long-term sources of minerals. Canadian mining companies would benefit as well, from the increased investment and improved market access. Western firms interested in participating in China's plans to increase its own domestic metal mining capacity should note that among the major needs will be engineering, technology and equipment.

The author also believes there is potential in the long term for Canada to develop a stronger position in Chinese metal markets. Some researchers have suggested that the best strategy for Canadian mineral companies continues to be simply to market their commodities in China; they advise against becoming actively involved in the exploration, mining and processing stages for minerals within China, because the risks to potential investors are unacceptably high. Much of the responsibility for these difficulties rests with the Chinese partners and official agencies. While it is true that international investors have found it difficult to negotiate and implement contracts with Chinese companies, the author would like to urge Canadian businesses not to give up on such ventures over the long term.

To date, the joint ventures that have been successful have tended to involve fabrication plants located in coastal areas and using imported metals. For the future, it might be possible to extend the success rate to mining and other ventures by collaboration with partners from some of China's closest Asian neighbours, such as Japan, Hong Kong, Taiwan and South Korea. These four are familiar with the culture, markets, and business practices in China.[35] They are astute in business, not only with their neighbours, but all over the world. The Japanese have made tremendous efforts to get to understand Europeans and North Americans, who have quite different cultural traditions

[34] Statistics Canada: Canada's trade with Asia/Pacific, 1988.

[35] Johnson, Charles J.: "Mineral Industry Strategies for Asia in the 1990s", Book of papers presented at the Mineral Outlook Conference '89, Ottawa, pp. 90-127.

than those in Japan. Asians find a second language, usually European, essential for any educated person. If China is to be seriously considered as an important market for Western producers as well as a commodity supplier in the future, more active two-way approaches are needed for both Chinese and Westerners in the time ahead. Linguistic skills, business and personal contacts, mutual understanding, and skills in dealing with each other can be acquired only with the passage of time.

9. Summary of Conclusions

A View of Reality and of the Future

China's metal mining sector and mineral trade are increasingly affected by both the domestic situation and changes in the international scene. The events of the late 1980s were a prelude to subsequent progress. Speaking optimistically, the author believes that China has the potential to be a vigorous competitor as well as a partner in global economic development, industrial adjustment, and environmental protection. Success in these areas on a global level cannot be accomplished without cooperation from China, with its enormous territory and the largest population in the world.

A realistic and long-term view of China's developing economy is essential. Moreover, the areas of comparative advantage of the industrial sectors of China, and those of its trading partners, should be understood, so that supply and demand for metals and extension of capacity in specific mining sectors can be coordinated to some degree. Such a wholistic approach would support a long-term economic relationship, rather than just a temporary and casual trading partnership. It would also encourage more efficient allocation of global financial resources, and more efficient use of global mineral resources.

China's Industrial Advantages and Shortcomings

China's industrial structure is basically diversified, with a comparatively well-developed manufacturing sector. However, as noted previously, public decision-making has diverted investment away from the resource sectors for a number of years. As a result, there is a significant weakness in China's economy, in the form of underdeveloped primary industries and a lack of infrastructure.

Although China is a world mining power in a number of commodities, its metal mining sector has developed in an unbalanced manner, and per-capita production and productivity are low. The result is a severe shortage of base metals and other minerals, with production far below the needs of the better-developed manufacturing industry. As a result, China has become a major importer of metals and concentrates since the mid-1980s. State austerity measures taken late in 1989 have temporarily reduced, but not eliminated, the problems caused by weakness in the energy, metallurgical and mining sectors.

Resources, Mining, Processing and Trade

China has good potential for some, but not all, mineral commodities. For example, bauxite, zinc, lead, nickel, tungsten, tin, molybdenum and mercury are plentiful. On the other hand, reserves are sparse for high-grade iron, manganese, copper and cobalt. Chrome and the platinum group metals are rare. With China's population of over 1.1 billion, or 22 percent of the world total, the richness of its mineral resources becomes rather modest in per-capita terms, at about half of the world level. Nevertheless, both abundant and scarce mineral resources can be developed, since China is capable of utilizing the most advanced mining technology and has the advantage of a large labour force. Economic ores and concentrates can be produced, even from modest grade iron or copper deposits, although considerable quantities of these products will still have to be imported for many years to come.

Performing as a Major Trader

World prices of tin, tungsten and wolfram products are determined in the London, New York and Tokyo metal markets. As one of the world's leading suppliers of these metals, China should participate in these market negotiations. Such

participation could help China to reduce the possibility of encouraging destructive downward trends in prices of raw materials in its trading practices, to develop sophisticated marketing, industrial, and trade policies.

Restructuring the Metal Mining Industry

Rapid improvements in the performance of China's metal mining sector will require a series of incentive policies, targeting metal mining as a priority industry, in addition to general economic reform. One of the key requirements is the formation of a distinctive industrial policy to guide the restructuring. Experiences in metal mining in recent years have revealed that producers function best as independent agents, responding to their own economic stimuli and obligations. Most metal mines should be freed from the control of state departments and allowed to perform as market-oriented entities in accordance with the general mining code. It is also urgent to train staff, to update technology, and to establish efficient management in this sector.

Improvement of Geological Service

Overstaffed, underemployed, with an multi-levelled administrative structure, the geological survey is not efficient and cannot use its limited operating budget effectively for mineral exploration activities. This situation could be changed by ceasing to rely solely on state budgets for financing. A user-fee system should be implemented for geological services.

The geological and exploration units must be transformed in order to become productive agencies. Proper selection, training and qualification standards for employees must be established and used. Better local decision-making capabilities are also needed in these geological and exploration units.

Mining Legislation and Regulation

China's economic legislation and regulations have been constituted mainly for the manufacturing sector, and must be broadened to accommodate concerns in the mining industry. Policies that give priority to downstream fabrication have impeded the development of the metal mining sector. Proper economic legislation and control must include appropriate concern for the mining sector's needs and specific characteristics.

The mining law must be enforced uniformly across the country, for both small and state-run operations. A long-term view of revenue maximization and rational use of mineral resources needs to be established, along the following lines:

- enforcement of the Mineral Resource Law and its principle of public sovereignty over mineral resources;
- licensing for exploration and mining in order to adequately control the presently chaotic use and waste of resources;
- reform of the price system initially to raise the prices of raw materials relative to those of finished products, and ultimately to dispense with mandated prices;
- development of a system of incentives and penalties to encourage the highest possible recovery of non-renewable mineral resources and to discourage wasteful mining practices.

Small-Scale Mining

Small-scale mining will continue. Potentially economic operations should be assisted in obtaining technological upgrading, improved management, and safety training. Short-term financial assistance may be given where necessary. Some of these mines will expand and become efficient.

Small-scale mining activity has penetrated every possible region and opportunity. In order to regulate its operations, a basic social and economic reform strategy, for both urban and rural areas, must be put in place. Successful restructuring of the mining sector will take place only after the problem of rural poverty has been resolved. It is essential to find employment for that segment of the rapidly rising population in mining areas which is not directly employed by the industry.

Price Structure Adjustment

Low domestic prices for most metal concentrates have caused hardship in the mining sector. Many mines face difficulties in meeting their wage bills and maintaining operations at reduced capacity; technological innovation is virtually impossible without state assistance. A freer market price for ingots and finished metal products might find smelting capacity "mysteriously" increased. The secondary system of parallel market prices, introduced in the mid-1980s and applicable only to production in excess of state requirements, has complicated the material supply and general economic situations chiefly by increasing the temptation for smuggling out of official allocation markets and into the secondary market. This was, to some degree, a cause of social unrest in the late 1980s. Purchasing monopolies in China, combined with low official prices for gold, tin, antimony and tungsten, created an opportunity for intermediate traders to deflect most products of small mines to the black market, and encouraged local corruption.

It is crucial to eliminate the dual-price system as quickly as possible and to link the internal prices of metallic minerals more closely to international market levels. An efficient industry must be built up so that, in the long term, mining activity is economic by world standards and can continue on a profitable basis. As a interim measure, the rewards for mining and processing, including the costs of royalties, exploration and development, must not be significantly lower than those of importing. In the long term, the price structure must move to the free market.

Tax Reform

A proper taxation system may be created with simultaneous reform of price system as mentioned above. A fixed or volume-based royalty and a flexible profit-based income taxation are recommended.

Before the price structure is modified significantly, it would be helpful to reduce taxes on mining products and income below those of manufacturing, and to reduce energy and transportation taxation surcharges for the mining industry as well. To keep some marginal but potentially economic mining properties in production, or prolong their life somewhat, tax-based incentives might be offered on an individual basis for a short time.

Investment Incentives

As long as mineral prices are not allowed to rise, even in a favourable demand environment, the investment capability of mining entities will remain weak. A policy of investment assistance and incentives is suggested. Long-term loans at low interest for some types of mining, and increased allocations from the state budget, as grants or subsidies to assist mining construction are two possible measures. When the economic environment improves, domestic and foreign investments would supplement these interim investment services.

Technology Updating

Most large- and mid-scale mines are still served by outdated techniques and equipment from the 1960-70s. One significant exception is the Antaibao open pit of the joint Sino-U.S. Pinso coal mine. Aside from low productivities, low levels of mechanization and too much reliance on manual labour have resulted in low productivity and high fatality rates. There is an urgent need to modernize and mechanize mining technology.

International and Sino-Canadian Trade

Due to China's internal situation, and the lack of experience among traders of both sides, international investors have had difficulties in working with Chinese partners in the past. If China is to be considered as a potential market as well as a commodity supplier for the rest of the world in the near future, then it must establish a more attractive environment for investment and trade. At the same time, more active two-way contacts between the Chinese and their potential partners must be developed. Both sides need to develop language skills, personal contacts and mutual understanding.

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